# EDUCATIONAL PSYCHOLOGY

A COGNITIVE VIEW

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# EDUCATIONAL PSYCHOLOGY

## A COGNITIVE VIEW

DAVID P. AUSUBEL
*Office of Research and Evaluation, Division of Teacher Education*
*The City University of New York*



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*To*

*Pearl, Fred, and Laura*

*If I had to reduce all of educational psychology to just one principle, I would say this The most important single factor influencing learning is what the learner already knows Ascertain this and teach him accordingly*

# PREFACE

THE BASIC PREMISE UNDERLYING THIS BOOK is that educational psychology is primarily concerned with the nature, conditions, outcomes, and evaluation of classroom learning Unlike most of its predecessors in the field, it does not conceive of educational psychology as an amalgam of learning theory, developmental psychology, mental hygiene, and educational and psycho logical measurement *More specifically this text differs from these other* works in the following six respects

First, it does not consider such topics as child development, adolescent psychology, the psychology of adjustment, mental hygiene, personality, and group dynamics as ends in themselves It considers them only insofar as *they bear on and are directly relevant to classroom learning* This *criterion* of relevance has, of course, also been adopted by other textbooks in the field, but more in theory than in actuality I have endeavored to include in this volume only psychological theory, evidence, problems, and issues that are of direct concern either to the serious student of education or to the future teacher in his role as facilitator of school learning

Second, it eliminates *entirely* many normally covered topics drawn from general and developmental psychology which bear little or no rela tion to classroom learning Examples include the nature and development of needs, general determinants of behavior, reactions to frustration, developmental tasks, mechanisms of adjustment, parent child relationships, noncognitive development during infancy and the preschool years, and physical development It is true, for example, that physical development during childhood affects motor coordination, writing, and popularity in the peer group, and that physical changes in adolescence affect the self concept, emotional stability, peer relations, and athletic skills But an edu cational psychology textbook cannot cover everything Prospective primary school teachers will presumably have a course in child development and prospective secondary school teachers will presumably have a course in adolescent psychology Similarly certain aspects of motivation *are* obviously relevant for classroom learning but a general discussion of needs their nature function development and classification such as would be appropriate in a course in general psychology hardly seems necessary

Third this text is principally concerned with the kinds of learning that take place in the classroom that is meaningful symbolic learning—both reception and discovery Some kinds of learning such as rote learning and motor learning are considered so inconsequential a part of school learning as to warrant no systematic treatment in a textbook on educational psychology Other kinds of learning for example the learning of values and attitudes are not considered indigenous to the primary or distinctive function of the school and are treated only insofar as they affect or are part of the learning of subject matter Their more general aspects are left to such courses as general and social psychology And still other kinds of learning for example animal learning conditioning instrumental learning and simple discrimination learning are considered irrelevant for most learning tasks in school despite the fact that wildly extrapolated findings in these areas quite commonly pad the learning chapters of many educational psychology textbooks

Fourth this work is not eclectic in theoretical orientation but proceeds from a consistent point of view based on a cognitive theory of meaningful verbal learning

Fifth greater stress is placed on cognitive development than in most other educational psychology texts and the material is integrated with related aspects of cognitive functioning

Finally a level of discourse is employed that is appropriate for prospective teachers and mature students of education Oversimplified explanations language and presentation of ideas are avoided Educational psychology is a complex rather than a simple subject Hence to oversimplify it is to render the beginning student a serious disservice Clarity and incisiveness of presentation do not require reversion to a kindergarten level of writing and illustration In fact it is the writer s firm conviction that much of the thinly disguised contempt many prospective teachers have for courses in pedagogy and educational psychology stems from watered-down repetitive content and an unnecessarily elementary level of vocabulary sentence structure illustration and example Illustrations tables and figures therefore are used in this text only where it is felt they could convey meanings more effectively and succinctly than could language they are not used to provide relief diversion sentimental atmosphere or an aura of scientific precision For the same reason and also because they are so space-consuming and so frequently accepted as evidence rather than as interesting illustrative matter, case histories and anecdotal material are not included in this volume

In short, the aim of this book is to furnish the prospective teacher with the basic psychological sophistication he will need for classroom teaching It should be supplemented by courses in general, developmental, and social psychology and cannot attempt to serve as a substitute for any or all of these subjects

My decision to restrict the discussion of learning to meaningful verbal learning points up the unfortunate paucity of experimental evidence in this area This situation is a reflection of the prevailing tendency, over the past three or more decades for educational psychologists to extrapolate findings from animal, rote, and perceptual motor learning experiments rather than to conduct research on meaningful verbal learning But presenting certain significant theoretical propositions without definitive empirical support was considered preferable to leaving large gaps in theory or filling them by means of unwarranted extrapolation In certain instances however, where abundant confirmatory research was available, considerations of space made judicious selection necessary Cited evidence, therefore, should be considered more illustrative than exhaustive

To be consistent with the pedagogic principles of progressive differentiation and integrative reconciliation (see Chapter 4), the book is organized in such a way that early chapters present an overview of later chapters, and the introductory material in each chapter performs the same function in relation to the material that follows Furthermore, when similar material is encountered again in a different context, deliberate repetition explicitly delineating similarities and differences is considered pedagogically superior to expecting the student to perform the necessary cross-referencing of related concepts and propositions by himself These devices render chapter summaries superfluous Unlike a summary, an overview orients the reader in advance When used as an organizer, it presents (at a higher level of abstraction, generality, and inclusiveness) an ideational scaffolding for the detailed material to follow It is also a well known fact that students frequently abuse summaries by using them as the *sole* basis for review

Several other familiar textbook features are missing in this book First, specific questions are not posed at the end of each chapter This degree of explicit guidance in review is considered more appropriate at the elementary and high school levels of instruction The use of an accompanying workbook was rejected for the same reason Second, chapter reading lists are not offered since it is believed that most students simply ignore suggested readings selected by the author The student who is genuinely interested in exploring original sources of particular interest to *him* can easily do so by identifying them in the text and then turning to the bib liography at the end of the book Lastly a file of test items is not made available to instructors using this text Evaluation of student *learning* is considered to lie within the latter s responsibility

I am indebted to my wife Pearl Ausubel and to Mrs Mary Stager for critical reading of the manuscript and for many helpful suggestions that have materially increased its clarity and readability Mrs Margaret Brengle and Miss Irene Pysanchyn were particularly helpful in preparing the manuscript for publication

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D P A

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Disillusionment regarding the relevance and usefulness of learning theory for educational practice has been responsible in part for the recent emergence of theories of teaching that are avowedly independent of theories of learning The justification of such theories has been advanced on both historical and logical grounds

### *The Historical Argument*

N L Gage cites the historical record to argue that theories of learning have had very little applicability to and influence on educational practice whether in education psychology textbooks in courses devoted to teaching methods or in the everyday operations of classroom teaching He argues further that theories of learning are *inherently irrelevant* for problems of instruction and should therefore be replaced by theories of teaching For example he states that

> while theories of learning deal with the ways an organism learns theories of teaching deal with the ways in which a person influences an organism to learn To satisfy the practical demands of education theories of learning must be stood on their head so as to yield theories of teaching (Gage 1964 pp 268 269)

This argument is based essentially on the historical failure of learning theory to provide a psychologically relevant basis for pedagogic practice But this undeniable shortcoming of learning theory to date is by no means a necessary or *inherent* limitation in the applicability of such theory to education it is merely characteristic of the *prevailing* brand of school learning theory which in general does not deal with the kind of learning that occurs in the classroom but rather has for the most part been uncritically extrapolated from the main body of laboratory learning theory A truly realistic and scientifically viable theory of classroom learning in contrast would be primarily concerned with the *complex* and *meaningful* types of verbal and symbolic learning that takes place in school and similar learning environments and would also give a prominent place to those *manipulable* factors that affect it There is in other words a very close relationship between knowing how a pupil learns and the manipulable variables influencing learning on the one hand and knowing what to do to help him learn better on the other By teaching we mean primarily the deliberate guidance of learning processes along lines suggested by relevant classroom learning theory It would seem reasonable therefore to suppose that the discovery of the most effective methods of teaching would be inherently dependent upon and related to the status of learning theory

Of course only *general* principles of facilitating school learning could be considered the domain of educational psychology The applied aspects of pedagogy derived from these principles would constitute a theory of instruction and would continue to be taught in methods courses—compa rable to the clinical phase of a medical student s *training* The methods courses would go into detail about the many complexities of the classroom teaching process both generally and for particular age groups and subject matters

### *The Logical Argument*

In contrast to Gage s historical argument which focuses on the failure of learning theory to prove relevant to educational practice B O Smith (1960) presents a strictly logical rationale for formulating theories of teach ing that are wholly independent of rather than complementary to theories of learning He bases his case on the propositions that learning and teach ing are not inextricable from each other and that a theory of learning can not tell us how to teach

First Smith s insistence that learning and teaching are different and separately identifiable phenomena admittedly does more than belabor the obvious It clears up some widely prevalent semantic confusion—since in his own words it is frequently implied that if the child has not learned the teacher has not taught or else has taught incompetently Teaching *and learning are not coextensive for teaching is only one of the conditions* which may influence learning Thus pupils can learn without being taught that is by teaching themselves and even if teaching is manifestly competent it does not necessarily lead to learning if the pupils concerned are inatten tive unmotivated or cognitively unprepared

Nevertheless once these unwarranted inferences about the coextensive ness of learning and teaching are discarded it is useful to focus on those aspects of teaching and learning that *are* related to each other These re ciprocal relationships include the purposes the effects and the evaluation of teaching Thus although it is true that teaching is logically distinct from learning and can be analyzed independently of what pupils learn what would be the practical advantage of so doing? The facilitation of learning is the only proper end of teaching We do not teach as an end in itself but only that pupils may learn and even though the failure of pupils to learn does not necessarily indict the competence of the teacher learning is still the only feasible measure of teaching merit. Further as was just pointed out teaching itself is effective only to the extent that it manipulates effec tively those psychological variables that govern learning

Second even though a valid theory of learning cannot tell us how to teach in a prescriptive sense it does offer us the most feasible point of de parture for discovering *general principles* of teaching that can be formu lated *in terms of both intervening* psychological processes and cause effect relationships It is largely from a theory of learning that we can develop defensible notions of how crucial factors in the learning teaching situation can be most effectively manipulated The only other possible approaches are to vary teaching factors at random or to rely on intuition The latter approaches not only are more time consuming but can also yield only purely empirical laws that cannot be formulated in general terms with respect to the psychological conditions and relevant *cognitive processes* involved

Of course an adequate theory of learning is not a sufficient condition *for the improvement of instruction Valid principles of teaching are* necessarily based on relevant principles of learning but as pointed out above are not simple and direct applications of these principles Laws of classroom *learning merely provide general direction for discovering effective teaching* principles they do not indicate *what* these teaching principles are The formulation of teaching principles requires much supplementary research *that takes account of practical problems and new instructional variables* not implicit in the learning principles themselves In other words one can consider the basic principles of teaching as applied derivatives of school *learning theory they are products of an engineering type of research* and are based on such modifications of learning theory as are necessitated by the practical difficulties or the additional new variables involved in the task of *teaching*

As B O Smith (1960) asserts simply by knowing the cause of a phenomenon one does not thereby acquire control of it for practical ends *Thus* for example *we can know the cause of a disease without knowing* how to treat it and we can treat a disease successfully without knowing its cause It is undeniable that many practical and useful inventions are made *accidentally without any understanding of how or why they work But who* would advocate this as a *deliberate* research strategy? Ordinarily scientists search for practical methods of control that can be related to general statements *of relationship among the relevant variables involved The superi*ority of this approach inheres in the fact that methods of control that are relatable to general principles not only are understandable and interpretable *but also are more widely transferable to other practical problems* We could for example discover as an empirical fact that using teaching method X facilitates learning But the practical value of such knowledge is quite *limited* Would it *not* be preferable to formulate the research problem so that we could ascertain in what ways method X influences relevant psychological variables and intervening cognitive states in the course of facilitating learning retention or problem solving? It is extremely wasteful of time and effort to search for more efficient methods of teaching that can be described only in terms of descriptive characteristics of the teaching act and *cannot* be related to laws of learning Even when scientists do stumble accidentally on useful empirical laws they immediately launch new hypothesis-oriented research to explain in more general terms the underlying basis of the accidental discovery

Finally although knowledge of causation does not imply immediate discovery of control procedures it does constitute a tremendous advantage in discovering such procedures For one thing it narrows the field for another it enables one to try procedures that have proven successful in controlling related conditions Knowing that tuberculosis was caused by a microorganism for example did not provide us immediately with a cure or a preventative But it enabled us to try such approaches as vaccines immune sera antisepsis quarantine and chemotherapy that had been used successfully in treating other infectious diseases In the same sense knowledge of the cause of cancer would help immeasurably in discovering a cure and knowledge of the nature and relevant variables involved in concept acquisition would be of invaluable assistance in devising effective methods of teaching concepts

As E R Hilgard points out however scientific practices in instruction need not necessarily wait upon agreement among learning theorists

> If one were unable to proceed without a learning theory upon which all agreed the situation would indeed be frightening At least two things need be said For one thing the disagreement among theorists may be in respect to the interpretation of a set of facts upon which as facts all agree in this case the issue often is not one to trouble the practical person at all Thus rewards may control learning in a given situation and be interpreted in contiguity terms in reinforcement terms or in information terms While eventually the correct interpretation might make some difference it often makes little difference at the present stage of technology Second the technology of instruction rests on much more than learning theory (Hilgard 1964 pp 402-403)

In conclusion therefore theories of learning and theories of teaching are interdependent rather than mutually exclusive *Both* are needed for a complete science of pedagogy and neither one is an adequate substitute for the other Theories of teaching must be based on theories of learning but must also have a more applied focus that is be concerned with more engineering kinds of problems

## Research Strategy in Educational Psychology

Few persons would take issue with the proposition that education is an applied or engineering science It is an applied[1] science because it is

[1] The term applied is used here to distinguish between sciences which are oriented toward *practical* ends as opposed to "basic sciences which do not have

concerned with the realization of certain practical ends which have social value The precise nature of these ends is highly controversial in terms of both substance and relative emphasis To some individuals the function of education is to transmit the ideology of the culture and a core body of knowledge and intellectual skills To others education is primarily con cerned with the optimal development of potentiality for growth and achieve ment—not only with respect to cognitive abilities but also with respect to personality goals and adjustment Disagreement with respect to ends how ever neither removes education from the category of science nor makes it any less of an applied branch of knowledge It might be mentioned in pass ing that automobile engineers are also not entirely agreed as to the char acteristics of the ideal car and physicians disagree violently in formulat ing a definition of health

Regardless of the ends it chooses to adopt an applied discipline be comes a science only when it seeks to ground proposed means to ends on empirically validatable propositions The operations involved in such an undertaking are commonly subsumed under the term research The ques tion under discussion here relates to the nature of research in applied science or more specifically in education Is educational research a field in its own right with theoretical problems and a methodology of its own or does it merely involve the operation of applying knowledge from pure scientific disciplines to practical problems of pedagogy?

Despite the fact that education is an applied science educational psy chologists have manifested a marked tendency to extrapolate research find ings uncritically from laboratory studies of simplified learning situations to the classroom learning environment This tendency reflects the fascination which many research workers feel for the basic science approach to re search in the applied sciences as well as their concomitant failure to ap preciate its inherent limitations They argue that progress in educational psychology is made more rapidly by focusing indirectly on basic science problems in general psychology than by trying to come to grips directly with the applied problems that are more indigenous to the field K W Spence (1959) for example perceives classroom learning as much too com plex to permit the discovery of general laws of learning and advocates a straightforward application to the classroom situation of the laws of learn ing discovered in the laboratory He sees very little scope however for applying the latter laws to problems of educational practice A W Melton (1959) and E R Hilgard (1964) take a more eclectic position They would search for basic science laws of learning in both laboratory and classroom contexts and would leave to the educational technologist the task of con

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this orientation *Applied* does not imply that the content of the practical disciplines consists of applications from the basic disciplines The problems rather than the knowledge of appl ed sciences are applied ducting the research necessary for implementing these laws in actual classroom practice

The position we have adopted thus far in this book is that the principles governing the nature and conditions of school learning can be discovered only through an applied or engineering type of research that actually takes into account both the kinds of learning that occur in the classroom as well as the salient characteristics of the learners We cannot merely extrapolate to classroom learning general basic science laws that are derived from the laboratory study of qualitatively different and vastly simpler instances of learning Attempts to do so are extremely tortuous as, for example, G Mandler s (1962) attempt to explain complex cognitive functioning in terms of the laws of association, or F D Sheffield s (1961) recent explanation of the hierarchial learning of sequentially organized materials in terms of the principle of contiguous conditioning

Laws of classroom learning at an *applied*[2] level are needed by the educational technologist before he can hope to conduct the research preparatory to effecting scientific changes in teaching practices He can be aided further by general principles of teaching which are intermediate, in level of generality and prescriptiveness between laws of classroom learning and the technological problems that confront him Contrary to K W Spence s (1959) contention the greater complexity and number of determining variables involved in classroom learning does not preclude the possibility of discovering precise laws with wide generality from one educational situation to another It simply means that such research demands experimental ingenuity and sophisticated use of modern techniques of research design

### *Basic Science versus Applied Approach*

Three different kinds of research orientations have been adopted by those who are concerned with scientific progress in applied disciplines such as medicine and education (a) basic science research (b) extrapolated research in the basic sciences and (c) research at an applied level (Ausubel, 1953)

The basic science research approach is predicated on the very defensible proposition that applied sciences are *ultimately* related to knowledge in the underlying sciences It can be demonstrated convincingly that progress in medicine is intimately related to progress in general biochemistry and bacteriology, that progress in engineering is intimately related to prog

[2] These laws are just as basic as basic science laws The terms basic and "applied refer to the distinction between basic ( pure ) and applied (practical) sciences made earlier Basic" does not mean fundamental In the latter sense applied research is just as basic for its domain as research in the pure sciences

because it is not oriented toward solving educational problems, and its findings, if relevant, are applicable only if much additional research is performed to translate general principles into the more specific form they have to assume in the task specialized and more complex contexts of pedagogy

These limitations would not be so serious if they were perceived In the latter event, it would be defensible for educational institutions to set aside a *small* portion of their research funds for basic science research as a long term investment. But since the limitations of this approach are *not* generally appreciated some bureaus of educational research confidently invest their major resources in such programs, and then complacently expect that the research findings which emerge will be both relevant and applicable in their original form to the problems of education

Naivete with respect to the second premise, that is, of immediate applicability, is especially rampant and has led to very serious distortions in our knowledge of those aspects of the psychology of learning that are relevant for pedagogy The psychology of learning that teachers study is based on findings in general psychology which have been borrowed wholesale without much attempt to test their applicability to the kinds of learning situations that exist in classrooms. It would be a shocking situation indeed if a comparable procedure were practiced in medicine, that is, if physicians employed therapeutic techniques validated only in the test tube or by animal experimentation

The second general research approach in the applied disciplines is extrapolated basic science research Unlike pure basic science research, it is oriented toward the solution of practical or applied problems It starts out by identifying significant problems in the applied field and designs experiments pointed toward their solution on a highly simplified basic science level In this way it satisfies the important criterion of relevance, but must still contend with the problem of level of applicability The rationale of this approach is that many practical problems are so complex that they must be reduced to simpler terms and patterned after simpler models before one can develop fruitful hypotheses leading to their solution Once the problems are simplified, control and measurement become more manageable

Depending on the nature of the problem under investigation, this approach may have genuine merit provided that the resulting research findings are regarded only as leads or hypotheses to be tested in the applied situation rather than as definitive answers to problems in pedagogy As already noted however educational researchers have a tendency to extrapolate basic science findings to pedagogical problems without conducting the additional research necessary to bridge the gap between the two levels of generality involved.

The third approach to educational research, research at the applied level, is the most relevant and direct of the three, *yet paradoxically is util ized least of all* by professional research workers in the field When research is performed in relation to the actual problems of education, at the level of complexity at which they exist, that is, under the conditions in which they are found in practice, the problems of relevance and extrapolation do not arise[3] Most rigorous research in applied disciplines other than educa tion is conducted at this level The research program of a hospital or medical school would be seriously unbalanced if most of its funds and efforts went into pure biochemical or bacteriological research instead of into applied and clinical research The major responsibility for furthering research in the former areas belongs to graduate departments of chemistry and bacteriology On the other hand, unless medical schools undertake to solve their own applied and clinical problems, who else will? And the same analogy obviously holds for education as well

Although applied research presents greater difficulties with respect to research design, control, and measurement, the rewards are correspondingly greater when these problems are solved Certainly such problems cannot be solved when they are deliberately avoided If other applied disciplines have been able to evolve satisfactory research methodologies there is no reason why education cannot also do so In fact, if any applied discipline with unique and distinctive problems of its own is to survive as a science, it has no choice in the matter—it is obliged to develop such methodologies

Many of the better known generalizations in educational psychology—the principle of readiness, the effects of overlearning the concrete to ab stract trend in conceptualizing the environment—illustrate the pitfalls of the basic science approach to educational research They are interesting and potentially useful ideas to curriculum specialists and educational tech nologists, but have little utility in educational practice until they are *par ticularized* at an applied level of operations The prevailing lack of practical particularization damages the image of educational psychology insofar as it induces many beginning teachers to nurture unrealistic expectations about the current usefulness of these principles These teachers after under going acute disillusionment may lose whatever original confidence they may have felt in the value of a psychological approach to educational problems

The need for applied research in these areas is well illustrated by the principles of readiness At present we can only speculate on what curriculum sequences might be if they took into account precise and detailed (but cur

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[3] Applied research is also directed toward the discovery of *general* laws within the framework of its applied ends The generalizations it discovers therefore exist at a different plane of generality than those of *basic* science research

rently unavailable) research findings on the emergence of readiness for different subject-matter areas, sub-areas, and levels of difficulty within areas. They would also have to take into account different methods of teaching the same material. Because of the unpredictable specificity of readiness as shown, for example, by the fact that four- and five-year-olds can profit from training in pitch but not in rhythm (Jersild and Bienstock, 1931, 1935), valid answers to questions such as those of readiness cannot be derived from logical extrapolation; they require meticulous empirical research in a school setting. The next step involves the development of teaching methods and materials appropriate for taking optimal advantage of existing degrees of readiness and for increasing readiness wherever necessary and desirable. But since we generally do not have this research data available, except perhaps in the field of reading, we can pay only lip service to principles of readiness in curriculum planning.

The basic science-extrapolation approach, of course, offers several very attractive methodological advantages in verbal learning experiments. First, by using nonsense syllables of equal meaningfulness, it is possible to work with additive units of equal difficulty. Second, by using relatively meaningless learning tasks such as equated nonsense syllables, it is possible to eliminate, for the most part, the indeterminable influence of meaningful antecedent experience, which naturally varies from one individual to another. But it is precisely this interaction of new learning tasks with existing knowledge in the learner that is the distinctive feature of meaningful learning.

Thus, although the use of nonsense syllables adds undoubted methodological rigor to the study of learning, the very nature of the material limits the applicability of experimental findings to a type of short-term discrete learning that is rare both in everyday situations and in the classroom. Nevertheless, even though there are no grounds for supposing that meaningful and nonmeaningful learning and retention occur in the same way, the findings from rote learning experiments have been commonly extrapolated to meaningful learning situations. One cannot have one's cake and eat it too. If one chooses the particular kind of methodological rigor associated with the use of rote materials, one must also be satisfied with applying the findings from such experiments only to rote learning tasks.

## Types of Learning

Much of the current confusion regarding the nature of learning is a reflection of the fact that, for a long time, psychologists, with few exceptions, have tended to subsume many *qualitatively* different kinds of learning under a single explanatory model. It has been assumed that the nature of the change called learning must in some fundamental sense be the same, regardless of what is being learned." But

> although the verification of general laws is surely a desirable objective, the assumption that the *kind of change* in capability being studied is always somehow "the same" may be unjustified. How much similarity is there, actually, between the kind of change represented by a child learning to say his first word, and that represented by a more experienced child learning to read printed English sentences? Or between learning to distinguish triangles from rectangles and learning to demonstrate that the sum of the internal angles of a triangle is the same as a straight angle? How much similarity is there between the learning of new 'facts' by a beginning chemistry student from a textbook, and the learning of new 'facts' by his chemistry professor from a technical journal? All of these are surely examples of learning, that is, they involve a change in capability which can be inferred from a before-and-after comparison of performance. But are they the same kind of change?
>
> Despite the prevailing emphasis on fundamental similarities of process in various learning situations, investigators of learning have always recognized certain 'types' of learning. There is "trial-and-error learning," 'discrimination learning,' "paired associate learning," 'concept learning," 'conditioned response learning" and so on. . . . But these varieties of learning have tended to be identified with certain kinds of stimulus situations generated by particular equipment or materials, like the bar pressing apparatus, or the memory drum with verbal syllables, or the maze with choice points. The tendency has *not* been for these types of learning to be distinguished in terms of the *kind of change in capability* they imply.
>
> The existence of differentiable performances as outcomes of learning naturally leads to the inference that different kinds of capabilities are established by learning. . . . [and] the identification of these different kinds of performance, together with the different kinds of capability they imply, suggests that there may be at least as many different kinds of learning. And if this is so, it may be supposed that there exist an equal number of *conditions of effective learning* to correspond with each variety. A theory of instruction, then, cannot be maximally useful if it concerns itself with only those conditions that are general to all classes of learning. Instead, such a theory must concern itself in an individual manner with *each* of the types of learning (Gagné, 1967, pp. 296-300).

Thus, from the standpoint of enhancing school learning, no theoretical concern is more relevant or urgent in the present state of our knowledge than the need for distinguishing clearly among the principal kinds of learning (rote and meaningful learning, concept formation, and verbal and nonverbal problem solving) that can take place in the classroom (Ausubel, 1961a). The most significant way of differentiating among these types of classroom learning is to make two crucial process distinctions that cut across all of them—one distinction between reception and discovery learning and another between rote and meaningful learning. The first distinction is significant because most of the understandings that learners acquire both in and out of school are presented rather than discovered And since most learning material is presented verbally it is equally important to appreciate that verbal reception learning is not necessarily rote in character and can be meaningful without prior nonverbal or problem solving experience

### *Reception versus Discovery Learning*

In reception learning (rote or meaningful) the entire content of what is to be learned is presented to the learner in final form The learning task does not involve any independent discovery on his part He is required only to internalize or incorporate the material (a list of nonsense syllables or paired adjectives a poem or geometrical theorem) that is presented to him so that it is available or reproducible at some future date In the case of meaningful reception learning the potentially meaningful task or material is comprehended or made meaningful in the process of internalization In the case of rote reception learning the learning task either is not potentially meaningful or is not made meaningful in the process of internalization

The essential feature of discovery learning whether concept formation or rote problem solving is that the principal content of what is to be learned is not given but must be discovered by the learner *before* he can incorporate it meaningfully into his cognitive structure The distinctive and *prior* learning task in other words is to discover something—which of two maze alleys leads to the goal the precise nature of the relationship between two variables the common attributes of a number of diverse instances and so forth The first phase of discovery learning involves a process quite different from that of reception learning The learner must rearrange information integrate it with existing cognitive structure and reorganize or transform the integrated combination in such a way as to generate a desired end product or discover a missing means-end relationship *After* discovery learning itself is completed the discovered content is made meaningful in much the same way that presented content is made meaningful in reception learning

It is evident therefore that reception and discovery learning are two quite different kinds of processes and as will be shown later that most classroom instruction is organized along the lines of reception learning In the next section it will be pointed out that verbal reception learning is not necessarily rote in character that much ideational material (concepts generalizations) can be internalized and retained meaningfully without prior problem solving experience and that at no stage of development does the learner have to discover principles independently in order to be able to understand and use them meaningfully

It is important to note at this point that reception and discovery learning also differ with respect to their respective principal roles in intellectual development and functioning (Ausubel 1961a) For the most part, large bodies of subject matter are acquired through reception learning, whereas *the everyday problems of living are solved through discovery learning* Nevertheless, some overlap of function obviously exists knowledge acquired through reception learning is also used in everyday problem solving and discovery learning is commonly used in *the classroom both to apply,* extend, clarify, integrate, and evaluate subject matter knowledge and to test comprehension In laboratory situations, discovery learning provides insight into scientific method and also leads to the contrived rediscovery of known propositions, and when employed by gifted persons it may generate significant *new knowledge In the more typical classroom situation, however,* the discovery of original propositions through problem solving activity is not a conspicuous feature in the acquisition of new concepts or information As far as the formal education of the individual is concerned the educational agency largely transmits ready made concepts, classifications and *propositions In any case, discovery methods of teaching hardly constitute* an efficient *primary* means of transmitting the *content* of an academic discipline

It may be argued with much justification, of course that the school is also concerned with developing the student s ability to use acquired knowledge *in solving particular problems, that is with his ability to think systematically,* independently, and critically in various fields of inquiry But this function of the school although constituting a legitimate objective of education in its own right, is less central than its related transmission of knowledge function in terms of the amount of time that can be reasonably *allotted to it, in terms of the objectives of education in a democratic society and in terms of what can be reasonably expected from most students*

From the standpoint of psychological process meaningful discovery learning is obviously more complex than meaningful reception learning it involves an antecedent problem solving stage before meaning emerges *and can be internalized (Ausubel 1961) Generally speaking however,* reception learning although phenomenologically simpler than discovery learning, paradoxically emerges later developmentally, and, particularly in its more advanced and pure verbal forms implies a higher level of cognitive maturity Greater intellectual maturity in this case makes possible a *simpler* and more efficient mode of cognitive functioning in the acquisition of knowledge

Thus concepts and propositions are *typically acquired during the post* infancy, preschool, and early elementary school years as a result of inductive processing of verbal and nonverbal concrete empirical experience—typically through autonomous problem solving or discovery The young child for example, acquires the concept of a chair by abstracting the common features of the concept from multiple incidental encounters with many different sizes, shapes and colors of chairs and then generalizing these attributes Re ception learning, on the other hand, although also occurring early, does not become a prominent feature of intellectual functioning until the child becomes sufficiently mature cognitively to comprehend verbally presented concepts and propositions in the absence of concrete, empirical experience (until he can comprehend, for example, the meaning of "democracy" or "acceleration" from their dictionary definitions). In other words, inductive concept *formation* based on nonverbal, concrete, empirical problem solving experience exemplifies early developmental phases of information processing, whereas simple concept *assimilation* through meaningful verbal reception learning exemplifies later stages.

### *Meaningful versus Rote Learning*

Although the distinction between reception and discovery learning discussed above has absolutely nothing to do with the rote-meaningful dimension of the learning process, the two dimensions of learning were commonly confused. This confusion is partly responsible for the widespread but unwarranted twin beliefs that reception learning is invariably rote and that discovery learning is inherently and necessarily meaningful. Both assumptions, of course, reflect the long-standing assumption, in many educational circles, that the only knowledge one *really* possesses and understands is knowledge that one discovers by oneself. Actually, each distinction (rote versus meaningful learning and reception versus discovery learning) constitutes an entirely independent dimension of learning. Hence, a much more defensible proposition is that *both* reception *and* discovery learning can be *either* rote *or* meaningful depending on the conditions under which learning occurs (Ausubel, 1961a). In both instances meaningful learning takes place if the learning task can be related in nonarbitrary, substantive (nonverbatim) fashion to what the learner already knows, and if the learner adopts a corresponding learning set to do so. Rote learning, on the other hand, occurs if the learning task consists of purely arbitrary associations, as in paired-associate, puzzle box, maze, or serial learning; if the learner lacks the relevant prior knowledge necessary for making the learning task potentially meaningful; and also (regardless of how much potential meaning the task has), if the learner adopts a set merely to internalize it in an arbitrary, verbatim fashion (that is, as an arbitrary series of words).

Insofar as classroom and similar kinds of learning are concerned, it is evident that meaningful learning is as preponderant with respect to rote learning as reception learning is with respect to discovery learning. Both within and outside the classroom, meaningful verbal learning is the principal means of acquiring large bodies of knowledge. Rote learning of lists of nonsense syllables or of arbitrarily paired adjectives may be characteristic of many research studies in the psychological laboratory, but is representative of few actual or defensible tasks in modern classrooms It is difficult indeed to find supportive evidence for *B J Underwood s assertion* that much of our educational effort is devoted to making relatively meaningless verbal units meaningful (Underwood 1959 p 11) To be sure *some classroom learning does somewhat approach the rote level—the letter* symbols in reading foreign language vocabulary the names of particular objects and concepts and the symbols used to represent the chemical elements This is so because the words or symbols chosen to represent the objects sounds or abstractions in question are purely arbitrary There is no good reason for example why the particular combination of sounds in chair' should have been chosen to represent the object it does Such learning however tends to form a very small part of the curriculum especially once children have mastered the basic letter and number symbols in the elementary school years

*Furthermore it is much less arbitrary to learn that a particular foreign* language word is equivalent in meaning to a word or an idea that is already meaningful—that garçon represents the meaning of already meaningful boy *—than to learn a list of paired adjectives such as unctuous-previous* arduous-reversible In the first case one is relating in some comprehensible fashion (on the basis of proposed equivalence) a new symbol to an already established and meaningful symbol in the learner s psychological structure of knowledge in the second case one is trying to establish a wholly arbitrary association between two already meaningful words that the learner very well knows are neither equivalent nor otherwise reasonably relatable to each other The learning of representational equivalents in other words may more properly be considered a primitive form of meaningful learning than a true variety of rote learning

It is true that much potentially meaningful knowledge taught by verbal exposition results in rotely learned verbalisms This rote outcome however is not inherent in the expository method but rather in such abuses of this method as fail to satisfy the criteria of meaningful learning (Ausubel 1961a)

There is much greater reluctance on the other hand to acknowledge that the aforementioned conditions of meaningful learning also apply to problem solving methods It should seem rather self evident both that performing laboratory experiments in cookbook fashion without understanding the underlying substantive and methodological principles involved confers precious little appreciation of scientific method and that discovering' correct answers to problems in mathematics and science without really understanding what one is doing adds *little either to knowledge or problem* solving ability Students accomplish this latter feat merely by rotely memorizing type problems and mechanical procedures for manipulating algebraic symbols *Nevertheless it is still not generally appreciated that* laboratory work and problem solving are not genuinely meaningful experi ences unless they are built on a foundation of clearly understood concepts and principles and unless the constituent operations are themselves meaningful

As indicated previously we shall be concerned in this volume only with meaningful kinds of learning both reception and discovery Excluded from consideration in addition to rote learning are such noncognitive (nonintellectual) kinds of learning as classical and instrumental conditioning and motorskills learning and such less complex kinds of cognitive learning as perceptual and simple discrimination learning The latter types of learning have only indirect tangential and occasional relevance for what is learned in the classroom We shall be concerned therefore with the complex varieties of meaningful cognitive learning (that is with the less immediate kinds of knowing understanding and problem solving that are dependent on the higher mental processes ) that comprise the bulk of intellectual activity in the school environment The psychology of specific school subjects however is not considered except by way of example since this book deals only with general principles of learning applicable to all variables and grade levels of subject matter The former topic is more indigenous to the clinical aspects of the pedagogic curriculum

## Classification of Learning Variables and the Organization of the Book

Inasmuch as instruction involves the manipulation of those variables (factors) influencing learning a rational classification of learning variables can be of considerable value in clarifying both the nature of the learning process and the conditions that affect it Such a classification also provides in a sense an organizational preview of this book since any textbook of educational psychology must of necessity be organized around the different kinds of factors influencing classroom learning

One obvious way of classifying learning variables is to divide them into *intrapersonal* (factors within the learner) and *situational* (factors in the learning situation) categories The *intrapersonal* category includes (a) *cognitive structure* variables—substantive and organizational properties of previously acquired knowledge in a particular subject matter field that are relevant for the assimilation of another learning task in the same field Since subject matter knowledge tends to be organized in sequential and hierarchical fashion what one already knows in a given field and how well one knows it obviously influences one s readiness for related new learnings (b) *developmental readiness*—the particular kind of readiness that reflects the learner s stage of intellectual development and the intellectual capacities and modes of intellectual functioning characteristic of that stage The cognitive equipment of the 15 year-old learner self-evidently makes him ready for different kinds of learning tasks than does that of the 6- or 10 year-old learner; (c) *intellectual ability*—the individual s relative degree of general scholastic aptitude (general intelligence or brightness level), and his relative standing with respect to particular more differentiated or specialized cognitive abilities How well a pupil learns subject matter in science, mathematics, or literature obviously depends on his general intelligence, his verbal and quantitative abilities, and on his problem solving ability, (d) *motivational and attitudinal factors*—desire for knowledge, need for achievement and self-enhancement, and ego-involvement (interest) in a particular kind of subject matter These general variables affect such relevant conditions of learning as alertness, attentiveness, level of effort, persistence, and concentration, (e) *personality factors*—individual differences in level and kind of motivation, in personal adjustment, in other personality characteristics, and in level of anxiety Subjective factors such as these have profound effects on quantitative and qualitative aspects of the learning process

The *situational* category of learning variables includes (a) *practice*—its frequency, distribution, method, and general conditions (including feedback or knowledge of results), (b) *the arrangement of instructional materials*—in terms of amount, difficulty, step size, underlying logic, sequence, pacing, and the use of instructional aids, (c) such *group and social factors* as classroom climate, cooperation and competition, social class stratification, cultural deprivation, and racial segregation, and (d) *characteristics of the teacher*—his cognitive abilities, knowledge of subject matter, pedagogic competence, personality, and behavior Gagne states that intrapersonal and situational variables

> undoubtedly have interactive effects upon learning The external variables cannot exert their effects without the presence in the learner of certain states derived from motivation and prior learning and development Nor can the internal capabilities of themselves generate learning without the stimulation provided by external events *As a problem for research, the learning problem is one of* finding the necessary relationships which must obtain among internal and external variables in order for a change in capability to take place Instruction may be thought of as the institution and arrangement of the *external* conditions of learning in ways which will optimally interact with internal capabilities of the learner, *so as to bring about a change in these capabilities* (Gagne 1967 p 295)

Another equally meaningful and useful way of classifying the same set of learning variables is to group them into *cognitive* and *affective social categories* The former group includes the relatively objective intellectual factors, whereas the latter group includes the subjective and interpersonal determinants of learning Since this scheme of categorization is somewhat however, that although this extreme position was often dominant in teachers colleges and schools of education it rarely prevailed, either in theory or in practice, in more than a handful of public schools Hence, present concern with intellectual training and with the quality of the curriculum is more a matter of increased emphasis than a radical shift in the goals of American education

Most teachers and school administrators as a matter of fact, have always agreed that the *distinctive* function of the school in our society is not to promote mental health and personality development, but to foster intellectual growth and to transmit subject matter knowledge The child centered versus the subject matter approach to education constitutes a pseudo-dichotomy that causes serious disagreement only among extremists at either end of the continuum No realistic advocate of the subject matter approach suggests that the school should disregard the personality development and social adjustment of pupils, or that subject matter should be taught without due regard for such relevant factors as readiness, motivation and individual differences in intellectual ability, and, similarly, constructive proponents of the child centered approach largely emphasize noncognitive determinants and outcomes of learning because of their importance in mastering subject matter

It must also be recognized, however, that greater emphasis upon intellectual competence can easily be perverted to serve undesirable purposes To begin with higher standards, more advanced content, and longer assignments are not ends in themselves They are valueless and even pernicious (a) unless the content of the subject matter involved is worthwhile, leads to meaningful knowledge, and is consonant with contemporary scholarship, and (b) unless the standards themselves are differentially applied so as to demand from each pupil what he can actually do and the best of which he is capable Raised standards must never be used as a means of eliminating from school those pupils in the lower range of intellectual ability Rather, new ways must be found to motivate such pupils adequately and to teach them academic subject matter more effectively Second excellence is not synonymous with high examination scores, one must consider the way in which such scores are achieved the kind of knowledge they reflect, and the motivation underlying them The intense competition today for entrance into prestige colleges and graduate schools has created a real danger that examination scores are fast becoming ends in themselves rather than symbols of genuine accomplishment and actual mastery of worthwhile knowledge

More important than what pupils know at the end of the sixth eighth, and twelfth grades is the extent of their knowledge at ages 25, 40, and 60, as well as their ability and desire both to learn more and to apply their knowledge fruitfully in adult life In the light of these latter criteria, in comparing, for example, the quantity and quality of our national research output with that of European countries, the American educational system stands up relatively well even though our school children are apparently exposed to less academic material Ostensibly higher academic standards may therefore have relatively little effect on real learning if they stress rote memorization of out dated subject matter content and slavish assimilation of the opinions of teachers and textbook writers Hence, in setting our academic goals, we must be concerned with the *ultimate* intellectual objectives of schooling, namely, with the long term acquisition of valid and usable bodies of knowl edge and intellectual skills, and with the development of ability to think critically, systematically, and independently

### *Knowledge as an End in Itself*

Related to the greater emphasis on intellectual training is an encourag ing recent trend to place higher value on the acquisition of knowledge as a significant end in itself It is true that the school cannot and dare not ignore totally the current concerns and the future family, vocational, and civic problems of high school students, particularly those who have no intention of attending college The danger of disregarding these latter concerns is that adolescents tend to lose interest in academic studies if they perceive the school as indifferent to their problems Some extreme proponents of the life adjustment movement however, carried this approach too far by adopting an anti intellectual and overly utilitarian attitude toward secon dary school education They tended summarily to dismiss, as a complete waste of time any branch of subject matter knowledge that had no immedi ate applicability to problems of everyday living and, in some instances, to dilute the curriculum by giving students a choice between academic subjects and various recreational frills and trivia It was sometimes held that only intellectually superior or college bound students should be exposed to substantial academic fare, and that other students should be given only prevocational and life adjustment' education

Learning tasks however need not necessarily be concerned with prob lems of adolescent adjustment in order to inspire adequate motivation and interest in high school students Meaningfully organized subject matter taught by competent teachers can generate considerable drive for learning as an end in itself The value of much school learning, after all, can be de fended only on the grounds that it enhances pupils understanding of important ideas in their culture—not because it has, even remotely, any practical uses or implications Nevertheless, some aspects of academic train ing do constitute, in a general way just as important a preparation for adult living as education that is explicitly directed toward vocational and family adjustment

### *Responsibility for Directing Education*

One extreme point of view associated with the child centered approach to education is the notion that children are innately equipped in some mysterious fashion for knowing precisely what is best for them This idea is obviously an outgrowth of predeterministic theories (for example, those of Rousseau and Gesell) that conceive of development as a series of internally regulated sequential steps that unfold in accordance with a prearranged design According to these theorists, the environment facilitates development best by providing a maximally permissive field that does not interfere with the predetermined processes of spontaneous maturation From these assumptions it is but a short step to the claim that the child himself must be in the most strategic position to *know* and *select* those components of the environment that correspond most closely to his current developmental needs and, hence, are most conducive to his optimal growth Empirical proof of this proposition is adduced from the fact that nutrition is adequately maintained, and existing deficiency conditions are spontaneously corrected, when infants are permitted to select their own diets If the child can successfully choose his diet, he must certainly know what is best for him in all areas of growth and should therefore be permitted to select everything including his curriculum

In the first place, and refuting this theory, even if development were primarily a matter of internal ripening, there would still be no good reason for supposing that the child is therefore implicitly conversant with the current direction and facilitating conditions of development and, hence, axiomatically equipped to make the most appropriate choices Because the individual is sensitive in early childhood to internal cues of physiological need, we cannot conclude that he is similarly sensitive to cues reflective of psychological and other developmental needs, even in the area of nutrition, self selection is a reliable criterion of need only during early infancy

Second unless one assigns a sacrosanct status to endogenous motivations, there is little warrant for believing either that they alone are truly reflective of the child s *genuine* developmental requirements or that environmentally derived needs are imposed,' authoritarian in spirit, and inevitably fated to thwart the actualization of his developmental potentialities Actually, most needs originate from without, in response to appropriate stimulation and successful experience and are internalized in the course of the child s interaction and identification with significant persons in his family and cultural environments

Third one can never assume that the child s *spontaneously* expressed interests and activities are completely reflective of *all* of his important needs and capacities Just because capacities can potentially provide their own motivation does not mean that they always or necessarily do so It is not the *possession of capacities per se that is motivating, but the anticipation* of future satisfactions once they have been successfully exercised But be cause of such factors as inertia, lack of opportunity, lack of appreciation, and preoccupation with other activities, many capacities may never be exercised in *the first place* Thus, *children typically develop only some of* their capacities, and their expressed interests cannot be considered coexten sive with the potential range of interests they are capable of developing with appropriate stimulation

In conclusion, therefore, the current interest and spontaneous desires of immature pupils can hardly be considered reliable guideposts and ade quate substitutes for specialized knowledge and seasoned judgment in de signing a curriculum *Recognition of the role of pupil needs in school* learning does not mean that the scope of the syllabus should be restricted to the existing concerns and spontaneously expressed interests that happen to be present in a group of children growing up under particular conditions of intellectual and social class stimulation In fact, one of the primary func tions of education should be to stimulate the development of motivations and interests that are currently nonexistent It is true that academic achieve ment is greater *when pupils manifest felt needs to acquire knowledge as an* end in itself Such needs, however, are not endogenous but acquired—and largely through exposure to provocative, meaningful, and developmentally appropriate instruction Hence, while it is reasonable to consider the views of pupils and even, under certain circumstances, to solicit their participation in the planning of the curriculum, it makes little developmental or admin istrative sense to entrust them with responsibility for significant policy or *operational decisions*

The school, of course, can never assume complete responsibility for the student s learning The latter must also bear his full share by learning ac tively and critically, by seeking persistently to understand and retain what he is taught, by integrating new learning tasks with previously acquired knowledge and idiosyncratic experience by translating new propositions into his own language, by putting forth the necessary effort to master difficult new subject matter, by asking significant questions and by conscientiously undertaking the problem solving exercises he is assigned All of this how ever, is a far cry from demanding that he take *complete* charge of his own learning It does not mean that he has to self-discover everything he learns, locate and interpret his own instructional materials from primary sources, design his own experiments, and merely use the teacher as a consultant and critic

The very nature of education as adequately guided instruction implies knowledgeable selection, organization, interpretation, and sequential ar rangement of learning materials and experiences by academically competent and pedagogically sophisticated persons rather than a trial and-error process of self instruction True, since education does not end when students leave school at the end of the day or at graduation time, *they must also be taught to learn by themselves* but these two aspects of education are by no means mutually preclusive Acknowledgement of the desirability of students devoting *part* of the school day to acquiring skill in locating interpreting, and organizing information by themselves does not in any way relieve the educational establishment of the *primary* responsibility of structuring subject matter content Teachers cannot in good conscience abdicate this responsibility by turning over to students in the name of democracy and progressivism the direction of education

Pedagogic irresponsibility also often hides behind the specious slogan that the function of the school is to teach children how to think—not what to think Here again we encounter a false dichotomy since the two functions are in no way mutually exclusive Actually, as has already been pointed out the transmission-of knowledge function of the school is more primary than its role in promoting problem solving ability Most of the critical thinking that goes on in the classroom is properly designed to facilitate the active and integrative assimilation of subject matter content, and whatever thinking power is fostered as an educational objective in its own right is typically considered a lesser objective than the teaching of subject matter and is teachable only in part Under no circumstances is discovery learning a feasible *primary* means of imparting subject matter knowledge Fortunately as evidenced by the phenomenal growth of curriculum reform movements and of various kinds of programmed instruction, leading educators are currently returning to the more traditional educational view that the content of the curriculum is the school s and not the student s responsibility

# MEANING AND MEANINGFUL LEARNING

Chapter 2

# MEANING AND MEANINGFUL LEARNING

SINCE THE PSYCHOLOGY OF CLASSROOM LEARNING is concerned mostly with the acquisition and retention of large bodies of meanings, it is important that we make very explicit at the outset what we mean by meaning and meaningful learning In this chapter, therefore, we shall explore the nature of meaning, examine some alternative theories of meaning, and consider the relationship of meaning to meaningfulness and meaningful verbal learning *In so doing, we shall also be concerned with such issues as the general* significance of meaningful learning in acquiring knowledge, how words, concepts, and propositions acquire meaning the distinction between logical and psychological meaning, and the difference between cognition and perception Lastly, we shall attempt to illustrate and concretize this abstract discussion of meaning and meaningful learning by showing briefly how important *such conceptions are for understanding how we learn the syntax* of our native language, how we learn to read, and how we learn second languages

## The Nature of Meaning

Meaningful learning involves the acquisition of new meanings, and new meanings conversely, are the products of meaningful learning That is, the emergence of new meanings in the learner reflects the completion of a meaningful learning process After indicating in some detail what is involved in this process we shall examine more explicitly both the nature of meaning *itself and its relationship to meaning learning*

### *The Conditions of Meaningful Learning*

The essence of the meaningful learning process, as we have already seen, is that symbolically expressed ideas are related in a nonarbitrary and substan tive (nonverbatim) fashion to what the learner already knows namely, to some existing relevant aspect of his structure of knowledge (for example an image an already meaningful symbol a concept or a proposition) Meaningful learning presupposes *both* that the learner manifest a meaningful learning set that is a disposition to relate the new material nonarbitrarily and substantively to his cognitive structure and that the material he learns be potentially meaningful to him namely relatable to his structure of knowledge on a nonarbitrary and nonverbatim basis (Ausubel 1961a) (see *A* in Table 1) Thus irrespective of how much potential meaning may inhere in a particular proposition if the learner s intention is to memorize it arbitrarily and verbatim (as a series of arbitrarily related words) both the learning process and the learning outcome must be rote or meaningless And conversely no matter how meaningful the learner s set may be neither the process nor the outcome of learning can possibly be meaningful if the learning task is not potentially meaningful—if it is not nonarbitrarily and substantively relatable to his cognitive structure

One reason why pupils commonly develop a rote learning set in relation to potentially meaningful subject matter is because they learn from sad experience that substantively correct answers lacking in verbatim correspondence to what they have been taught receive no credit whatsoever from certain teachers Another reason is that because of a generally high level of anxiety or because of chronic failure experience in a given subject (reflective in turn of low aptitude or poor teaching) they lack confidence in their ability to learn meaningfully and hence perceive no alternative to panic apart from rote learning (This phenomenon is very familiar to mathematics teachers because of the widespread prevalence of number shock or number anxiety ) Lastly pupils may develop a rote learning set if they are under excessive pressure to exhibit glibness or to conceal rather than admit and gradually remedy original lack of genuine understanding Under these circumstances it seems easier and more important to create a spurious impression of facile comprehension by rotely memorizing a few key terms or sentences than to try to understand what they mean Teachers frequently forget that pupils become very adept at using abstract terms with apparent appropriateness—when they have to—even though their understanding of the underlying concepts is virtually nonexistent

Whether the learning task is potentially meaningful (nonarbitrarily and substantively relatable to the learner s structure of knowledge) is a somewhat more complex matter than meaningful learning set At the very least it obviously depends on the two principal factors involved in establishing this kind of relationship that is both on the nature of the material to be learned and on the nature of the *particular* learner s cognitive structure (see Table 1) Turning first to the nature of the material it must self-evidently be sufficiently nonarbitrary or nonrandom itself that it could be related on a

TABLE 1

RELATIONSHIPS BETWEEN MEANINGFUL LEARNING, POTENTIAL MEANINGFULNESS LOGICAL MEANINGFULNESS, AND PSYCHOLOGICAL MEANING

| | | | | | |
|---|---|---|---|---|---|
| A | MEANINGFUL LEARNING or THE ACQUISITION OF MEANINGS | requires | (1) Potentially Meaningful Material | and | (2) Meaningful Learning Set |
| B | POTENTIAL MEANINGFULNESS | depends on | (1) *Logical Meaningfulness* (the nonarbitrary and substantive relatability of the learning material to correspondingly relevant ideas that lie within the realm of human learning capability) | and | (2) The availability of such relevant ideas in the *particular* learner's cognitive structure |
| C | PSYCHOLOGICAL MEANING (IDIOSYNCRATIC PHENOMENOLOGICAL MEANING) | is the product of | Meaningful Learning | or of | Potential Meaningfulness and Meaningful Learning Set |

nonarbitrary and substantive basis to correspondingly relevant ideas that lie within the realm of human learning capability (to correspondingly relevant ideas that at least *some* human beings are capable of learning if given the opportunity to do so) This property of the learning task itself that determines whether or not it is potentially meaningful is referred to as logical meaningfulness it seldom, if ever is lacking in school learning tasks since subject matter content, almost by definition, is logically meaningful Such is not the case however, with respect to many laboratory and everday learning tasks (for example, telephone numbers, paired adjectives, scrambled sentences lists of nonsense syllables) which are relatable to anyone s cognitive structure on only an arbitrary and verbatim basis

The second factor determining whether learning material is potentially meaningful is a function of the learner s cognitive structure rather than of the learning material The acquisition of meanings as a natural phenomenon occurs in *particular* human beings—not in mankind generally Hence, for meaningful learning to occur in fact it is not sufficient that the new material simply be nonarbitrarily and substantively relatable to correspondingly relevant ideas in the abstract sense of the term (to correspondingly relevant ideas that *some* human beings *could* learn under appropriate circumstances) it is also necessary that such relevant ideational content be available in the cognitive structure of the *particular* learner It is apparent, therefore, that insofar as meaningful learning outcomes in the classroom are concerned, the availability and other significant properties of relevant content in different learners cognitive structures constitute the most crucial and variable determinants of potential meaningfulness Thus it follows that the potential meaningfulness of learning material varies not only with prior educational background but also with such factors as age, IQ occupation, and social class and cultural membership

What precisely is meant by the statement that for learning material to be logically meaningful it must be nonarbitrarily and substantively relatable to correspondingly relevant ideas that lie within human learning capacity? The first criterion—nonarbitrary relatability—as suggested above, simply implies that if the material *itself* exhibits sufficient nonarbitrariness (or nonrandomness) an adequate and almost self evident basis exists for relating it in nonarbitrary fashion to the kinds of correspondingly relevant ideas that human beings are capable of learning Logically meaningful learning material could thus be nonarbitrarily relatable to *specifically* relevant ideas as examples derivatives special cases extensions elaborations modifications qualifications and more inclusive generalizations or it could be relatable to a *wider array* of relevant ideas in the sense of being generally congruent with them

The second criterion—substantive relatability—implies that if the learning material again is sufficiently nonarbitrary, an ideationally equivalent symbol or group of symbols could be related to cognitive structure without any resulting change in meaning In other words, neither mean ingful learning nor emergent meaning are dependent on the *exclusive* use of *particular* signs and no others, the same concept or proposition could be expressed in synonymous language and would convey precisely the same meaning Thus, for example, 'canine, 'Hund, and 'chien would elicit the same meanings as 'dog" in a person who has a fair command of English, German, and French, and 'All of the internal angles of a triangle equal a straight angle" would mean the same to most geometry students as "All of the interior angles of a triangle equal 180 degrees '

Rote learning tasks, of course, are not mastered in a cognitive vacuum They *are* relatable to cognitive structure but *only* in an arbitrary, verbatim fashion that does not result in the acquisition of any meanings Since, for example, the particular stimulus and response members of a given pair of adjectives in paired associate learning are linked together in purely arbitrary fashion, there is no possible basis for nonarbitrarily relating the learning task to anyone s cognitive structure, and the learner must also remember verbatim the response to each stimulus word—he cannot use synonyms This arbitrary and verbatim relatability of rote learning tasks to cognitive structure does, of course, have certain significant consequences for learning First, since human cognitive equipment, unlike a computer, cannot handle information very efficiently that is related to it on an arbitrary and verbatim basis, only relatively short learning tasks can be internalized in this fashion, and these can be retained for only short periods of time unless greatly over learned Second arbitrary and verbatim relatability to cognitive structure makes rote learning tasks highly vulnerable to interference from previously learned and concurrently encountered similar materials As we shall see later, it is this basic difference in kind of relatability to cognitive structure (arbitrary and verbatim versus nonarbitrary and substantive) that accounts for the fundamental difference between rote and meaningful learning pro cesses

It is also true that *already meaningful component* elements of a rote learning task can be related to cognitive structure in ways that do not in volve any learning of the elements themselves but nevertheless facilitate the rote learning of the task as a whole It is by virtue of such relatability, for example, that the component letters of nonsense syllables are *perceived* meaningfully, and that the syllables as a whole evoke associations to similar meaningful words (and are thus perceived as partly meaningful themselves) For similar reasons—by enhancing the familiarity of the material, by obviat ing the need for prior learning of the component elements, and by making possible the combination of these elements into larger units (thereby reduc ing the total number of discrete associations to be established)—the use of already meaningful component elements in learning material facilitates rote learning

### *Relationship of Meaning to Meaningful Learning*

Our discussion of meaningful learning thus far leads to the conclusion that *meaning itself* is a product of the meaningful learning process, and refers to the differentiated cognitive content evoked in a given learner by a particular symbol, or group of symbols, after either of these expressions has been meaningfully learned Why this is the case can be deduced directly from what is involved in meaningful learning At the very onset of such learning we start with a symbolic expression that is only potentially meaningful to the learner or as yet has no actual meaning for him This expression is then nonarbitrarily and substantively related to, and correspondingly interacts with, relevant ideas in his cognitive structure At the conclusion of the learning process, therefore, it follows that the *product* of this interaction (which product is itself a differentiated cognitive content) constitutes the meaning of the newly learned symbolic expression and will henceforth be evoked when the latter is presented

### *Types of Meaningful Learning*

The most basic type of meaningful learning upon which all other meaningful learning depends is *representational* learning, that is, learning the meanings of single symbols (typically words) or learning what they represent Single words in any language after all, are conventional or socially shared symbols each of which represents a unitary object, event, situation, concept, or other symbol in the physical, social, and ideational worlds To any *uninitiated* individual however, what a given symbol means or represents, is at first something completely unknown to him, it is something that he has to learn The process whereby he learns this is called representational learning and is coextensive with the process whereby new words come to represent for him the corresponding objects or ideas to which the words refer (their referents) that is the new words come to signify to him the same things that the referents do or to elicit the same differentiated cognitive content that they do

For example when a child is first learning the meaning of the word dog it is proposed to him that the sound of the word (which is potentially meaningful but as yet has no meaning for him) represents, or is equivalent to a particular dog-object that he is perceiving at the moment, and hence that it signifies the same thing (an image of this dog-object) that the object itself does He in turn actively relates—in relatively nonarbitrary and substantive fashion—this proposition of representational equivalence to relevant content in his cognitive structure Thus when meaningful learning is completed the word dog is reliably capable of eliciting differentiated cog nitive content (a composite image of the various dogs in his experience) that is approximately equivalent to that elicited by particular dog-objects

How representational learning actually occurs, and how children develop a capacity for such learning, will be discussed later in this chapter in some detail under the heading of "Types of Vocabulary Learning" At this point we wish only to distinguish between two basic kinds of meaningful learning, *representational learning* and *propositional learning* Representational learning concerns the meanings of unitary symbols or words and propositional learning concerns the meanings of ideas expressed by groups of words combined into propositions or sentences In the first instance (as in naming, labeling, and defining activities), learning the meanings of single words involves learning what they represent or, in effect, learning specific propositions of representational equivalence It means learning that particular symbols represent or are equivalent in meaning to particular referents In the second instance or in *true* propositional learning, the meaningful learning task is not to learn what words singly, or in combination, *represent*, but, rather, to learn *the meaning of new ideas expressed in propositional form* In true propositional learning, in other words, the object of the learning is not to learn propositions of representational equivalence, but to learn the meaning of verbal propositions that express ideas other than those of representational equivalence

In true verbal propositional learning, one is, of course, learning the meaning of a new *composite* idea in the sense that (a) the proposition itself is generated by combining or relating to each other multiple individual words, each representing a unitary referent, and (b) the individual words are combined in such a way (usually, in sentence form) that the resulting new idea is more than just the sum of the meanings of the component individual words Obviously before one can learn the meanings of verbal propositions one must first know the meanings of their component terms, or what the terms represent Thus representational learning is basic to, or a prerequisite for, true propositional learning when propositions are expressed in verbal form

A third type of meaningful learning that is prominent in the acquisition of subject matter consists of *concept learning* Concepts (unitary generic or categorical ideas) are also represented by single symbols just as other unitary referents are Except in very young learners, as a matter of fact, the individual words that are commonly combined in sentence form to constitute propositions actually represent concepts rather than objects or events, and hence propositional learning largely involves learning the meaning of a composite idea generated by combining into a sentence single words each of which represents a concept

At this point, it is obviously necessary to indicate how concept learning is related to representational learning Since concepts, as well as objects and events are represented by words or names, learning what *concept words* mean (learning which concept is represented by a given new concept word, or learning that the new concept word is equivalent in meaning to whatever the concept itself means) is self-evidently a major type of *representational* learning. It typically follows concept learning itself, inasmuch as it is very convenient to be able to represent a newly learned concept by a single word that is equivalent to it in meaning. But learning what the concept *itself* means, which, in effect, consists of learning what its criterial (distinguishing or identifying) attributes are, involves a very different type of meaningful learning that, like propositional learning, is substantive in nature and intent rather than nominalistic or representational. These two types of meaningful learning (conceptual and propositional) differ in that in the former instance the *criterial attributes* of a new concept are related to cognitive structure to yield a new generic but *unitary* meaning, whereas in the latter instance a new *proposition* (or composite idea) is related to cognitive structure to yield a new *composite* meaning. They are *both* very different from representational learning even though concept learning is typically followed by a form of representational learning in which the newly learned concept is equated in meaning with the concept word that represents it.

## Logical and Psychological Meaning

In the previous discussion we have distinguished between the *potential* meaning inherent for particular learners in certain symbolic expressions and in the statement of certain propositions on the one hand, and *actual* (phenomenological or psychological) meaning, which is the product of a meaningful learning process on the other. Actual meaning, according to this view, emerges when this potential meaning becomes converted into new, differentiated and idiosyncratic cognitive content within a *particular* individual as a result of being nonarbitrarily and substantively related to, and interacting with, relevant ideas in his cognitive structure. Our task in this section is simply to make explicit the analogous distinction between logical and psychological meaning (see Table 1). Psychological meaning is identical with actual or phenomenological meaning as defined above, whereas logical meaning corresponds to the meaning which learning material exhibits if it meets the *general* or nonidiosyncratic requirements for potential meaningfulness. In short, logical meaning depends *only* on the nature of the material. It is one of the two prerequisites that together determine whether learning material is potentially meaningful to a particular learner, the other prerequisite being the availability of the appropriate relevant content in this *particular* learner's cognitive structure.

*Logical* meaning therefore refers to the meaning that is inherent in certain kinds of symbolic material by virtue of its very nature. Such material manifests logical meaning if it can be related on a nonarbitrary and substantive basis to correspondingly relevant ideas that lie within the realm of human learning capability For example, if propositional material itself consists of generally nonarbitrary relationships, then it is also, almost by definition, nonarbitrary and substantively relatable to the aforementioned relevant ideas and thus logically meaningful Obviously excluded, therefore, from the domain of logical meaning is the almost infinite number of possible relationships between concepts that can be formulated on the basis of purely *random* or arbitrary pairings This does not necessarily mean that all propositions with logical meaning are empirically *valid* or even logically defensible *The questions of empirical and logical validity are issues that* simply do not enter into the determination of logical meaning Propositions based on unvalidated premises or on faulty logic may conceivably abound in logical meaning

*Psychological* (actual or phenomenological) meaning, on the other hand, is a wholly *idiosyncratic* cognitive experience Corresponding to the distinction between the logical and the psychological structure of knowledge, there is an equally important distinction between logical and psychological meaning Subject matter content can, at best, have logical meaning It is the nonarbitrary and substantive relatability of logically meaningful propositions to a *particular* learner s cognitive structure that makes them potentially meaningful to him and thereby creates the possibility of transforming logical into psychological meaning in the course of meaningful learning *Thus the emergence of psychological meaning depends not only* on presenting the learner with material manifesting logical meaning, but also on the latter s actual possession of the necessary ideational background

When an individual learns logically meaningful propositions, therefore, they automatically lose their nonidiosyncratic flavor Psychological meaning is always an idiosyncratic phenomenon Its idiosyncratic nature however, does not rule out the possibility of social or shared meanings The various individual meanings which different members of a given culture have for the same concepts and propositions are ordinarily sufficiently similar to permit interpersonal communication and understanding This homogeneity *of shared meanings within a particular culture, and even between* related cultures, reflects both the same logical meaning inherent in logically meaningful concepts and propositions as well as many common aspects of ideational background in different learners' cognitive structures

## Meaningful Learning versus the Learning of Meaningful Material

Meaningful learning is not to be interpreted as the learning of meaningful material In meaningful learning, the materials are only *potentially* meaningful If they were *already* meaningful, the goal of meaningful learning that is, the acquisition of new meanings, would be already accomplished by definition before any learning was ever attempted It is true, of course, that in most potentially meaningful learning tasks, the *component parts* of the material are already meaningful but in these instances the *task as a whole* is only potentially meaningful For example, in learning a new geometrical theorem each of the component words is already meaningful but the learning task as a whole (learning the meaning of the theorem) is yet to be accomplished Thus *already* meaningful material, just like its already meaningful component parts may be *perceived* or otherwise reacted to meaningfully, but it cannot be meaningfully *learned*

This brings us to the important distinction between the *meaningful* learning of *potentially* meaningful material and the *rote* learning of tasks that contain *already meaningful* components There are innumerable examples of rote or nonmeaningful learning In learning a list of paired adjectives, for example, each adjective is already meaningful, but the learning task itself is not potentially meaningful because these wholly arbitrary associations between adjectives cannot be related to the learner's existing knowledge in a nonarbitrary, nonverbatim fashion In learning a geometrical theorem, on the other hand each component word is not only already meaningful but the learning task as a whole is also potentially meaningful However, unless the learner manifests a meaningful learning set in this latter instance no meaning will emerge he will merely learn rotely a series of arbitrarily related words that cannot be nonarbitrarily and substantively related to his structure of knowledge Thus, it is important to distinguish between the *meaningful* learning of *potentially* meaningful material, on the one hand and on the other, the *rote* learning of already meaningful component elements that, taken together, either do or do not constitute potentially meaningful learning tasks

## *Meaning versus Meaningfulness*

What do investigators of rote verbal learning mean when they talk about the *meaningfulness* of the units (nonsense syllables, words) which they employ in their learning tasks? In using this term they do not refer to the substantive meaning of a given symbol (the differential cognitive content it evokes in the learner after being meaningfully learned), but rather to the *relative degree* of meaning it manifests as compared to that manifested by other symbols The meaningfulness of a word, for example, depends on whether it has a concretely identifiable referent (such as, 'book ) or merely serves a transactional function (such as since ) (Epstein, Rock, and Zuckerman 1960) and also on such factors as the frequency and variety of the contexts in which it is encountered (Bjorgen, 1964, Noble, 1953, Underwood and Schulz, 1960) A highly meaningful word, therefore, tends to be subjectively more familiar (Noble, 1953) and to evoke more associations (Glaze, 1928, Noble, 1952) than a less meaningful word—but these are indices of its meaningfulness rather than explanations of how it becomes meaningful in the first place One must be careful, in other words, not to confuse the mechanism whereby a word acquires meaning with the factors accounting for the relative degree of meaning it exhibits Reference has already been made to the reasons why meaningfulness facilitates rote learning

## The Acquisition of Meanings

In this section we propose to discuss more systematically some of the problems involved in the acquisition of word and propositional meanings Thus far, the acquisition of these latter types of meanings has just been considered illustratively in clarifying the nature of meaning The acquisition of concept meanings will be considered here only insofar as such learning must be distinguished from the learning of what concept words mean More definitive treatment of concept learning will be found in Chapter 15

### *Vocabulary or Representational Learning*

We have already indicated that learning the meanings of single words or learning what single words represent, involves the meaningful learning of *particular propositions of representational equivalence*—*learning* that particular words represent and thereby signify psychologically the same things that their referents do It was also pointed out that as a result of such learning, words come to elicit approximately the same differentiated cognitive content that their referents do Our task at this point is to relate more explicitly this particular type of meaningful learning, namely, representational learning to the previously presented paradigm of the meaningful learning process and to the previous discussion of the nature of meaning itself In other words, how do human beings acquire vocabulary? How do they actually learn what single words mean, and how does such learning exemplify meaningful learning in general?

To begin with, there is the matter of genic endowment without which no amount of appropriate experience would suffice Unlike subhuman species, human beings *have a genetically determined potentiality for representational learning* As stated earlier, representational learning is learning that a given pattern of stimulation (such as the distinctive pattern of sounds in the symbol dog ) represents and thereby signifies approximately the same thing (a dog image) that an entirely unrelated pattern of stimulation (such as the referent dog-object) signifies (When a given referent actually signifies something to a particular learner it is conventionally referred to as a "significate.") The principal step in actualizing this potentiality for representational learning is typically taken near the end of the first year of life, when the child acquires the *general insight* that it is possible to use a symbol to represent any significate. He acquires this insight by generalizing, subverbally and intuitively, from multiple exposures to the two complementary forms of the proposition of representational equivalence that more proficient users of his native language arrange for him—that different referents have different names and that different exemplars of the same referent have the same name.

Once this insight is firmly established in cognitive structure, it lays the necessary foundation for all subsequent representational learning. Thereafter, when a particular new proposition of representational equivalence is presented to him (that "dog" is representationally equivalent to different dog-objects and, hence, to their corresponding dog images), he is able nonarbitrarily and substantively to relate such a proposition as an exemplar to the already established and more generalized version of the same proposition in his cognitive structure. The resulting product of the interaction between the two propositions is the differentiated cognitive content that "dog" signifies, or is representationally equivalent to, a composite dog image, and presentation of the word "dog" will subsequently elicit this image. At this stage of the game, a particular proposition of representational equivalence may often be learned and retained for a surprisingly long time, even though it is put to the child only once and in connection with a single exemplar of the significate in question, provided of course, that the latter is familiar to him.

TYPES OF VOCABULARY LEARNING. In the early stages of vocabulary learning, words tend to represent actual and noncategorical objects and events, and hence to be equated in meaning with the relatively concrete and specific images such referents signify. Thus, naming, the earliest form of vocabulary learning in children, involves the establishment of representational equivalence between first-order symbols and concrete images. Later on, as words begin to represent concepts or generic ideas, they become concept names and are equated in meaning with more abstract, generalized, and categorical cognitive content. The word "dog" to a toddler may just signify a composite image of his own pet and of the particular dogs in his neighborhood; to the older preschool child, however, it signifies the *criterial attributes* of a composite dog image which he himself has discovered inductively from his own concrete-empirical experience with dogs. (This latter discovery process is called "concept formation" and is discussed in detail in Chapter 15.) Correlated with the *denotative* meaning of "dog" that emerges when the criterial attributes of this concept are meaningfully learned, are various idiosyncratic affective and attitudinal reactions that the term elicits in each child depending on his particular experience with the species These reactions constitute the *connotative* meaning of dog It should be noted however that in older children the connotations of most words for instance divorce alcohol communism are not acquired through first hand experience but are assimilated from prevailing evaluative attitudes in their immediate cultural environment

After the preschool years the meanings of most new words are learned by definition or by being encountered in appropriate and relatively explicit *contexts In this case representational equivalence is established in cognitive* structure between synonyms and already meaningful words or between new concept words and the meanings conveyed by their respective definitions or contexts An adequate definition or context furnishes in turn the criterial attributes of the new concept expressed in already meaningful words or combinations of such words For example in learning the meaning of the new concept *word* president (a form of representational learning typically *following* concept learning itself) a pupil equates the word in meaning to whatever chief of state or chief executive in a republic *means to him He does so after he learns what these attributes presented in* the definition[1] mean (concept learning) However only the representational learning that *follows* concept learning namely the process of equating the concept word in meaning with what the concept itself means can be legitimately considered part of vocabulary learning since by any reasonable standard vocabulary learning is synonymous with representational learning According to the generally accepted meaning of the expression acquiring a vocabulary consists of learning a body of word meanings which by definition refers to learning what the words mean and not to learning what their *referents mean Thus using the term vocabulary learning to encompass* concept learning as well as learning what concept words mean although very commonly done only generates conceptual confusion

Learning what concept words mean obviously demands more sophisticated *prior* knowledge about their corresponding referents than does other forms of representational learning since learning the meaning of concept words differs in one important respect from learning the meaning of words that do not represent concepts Where the referent of a given word is an *actual* object or event learning that the word signifies the same thing as the referent does not really involve a prior *substantive* task of *learning* what the referent itself signifies Getting to know what an object or event signifies is a simple matter of perception An object simply signifies the corresponding

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[1] When the criterial attributes of a concept are presented to the learner by definition or context rather than discovered by him as in the case of concept formation concept learning is referred to as concept assimilation In both instances however whether the criterial attributes are discovered or presented they must be meaningfully related to cognitive structure before concept meanings emerge

perceptual image it evokes when present, or the corresponding memory image that remains, and can be otherwise evoked when the object is no longer present However when the referent of a word is a concept (an abstraction or a generic idea that does not actually exist) learning that the concept word signifies the same thing as the referent, *does* involve a prior substantive task of learning what the referent signifies One can get to know what the concept itself signifies only by *learning* what its criterial attributes are and what they mean This, by definition, is a substantive form of meaningful learning Thus learning the meaning of a concept word always presupposes that the learner *first meaningfully learn* what its referent (the concept) signifies, even though the actual *representational* learning involved is essentially no different in process than that involved in learning the meaning of words that do not represent concepts

The practical importance of distinguishing carefully between learning the meanings of concepts and learning the meanings of concept words can be illustrated by citing several everyday and educational examples First, it not infrequently happens, particularly in concept formation, that pupils acquire particular concepts meaningfully without learning for quite some time what their names are, thus simply because they do not know what particular concept words mean, it cannot be assumed that they necessarily do not know the corresponding concept meanings Second, it is very possible either to forget what a given concept word means but to remember its corresponding concept meaning, or to remember a concept word but to forget its meaning Third, in teaching native language synonyms or foreign language equivalents of native language words, it is important to appreciate that pupils only have to learn new concept words—not new concepts Thus it is only necessary for them to equate in meaning the old concept words and the corresponding new synonyms or foreign language equivalents, it is superfluous and wasteful of time for them to equate in meaning the new concept words and the referents of the old concept words

Finally if concepts are rotely learned as a result of relating their criterial attributes arbitrarily and verbatimly to cognitive structure, it necessarily follows that the corresponding concept words are also rotely learned The proposition that a given concept word is equivalent in meaning to a referent that itself does not signify anything meaningful is so thoroughly arbitrary that it cannot possibly be nonarbitrarily and substantively related to cognitive structure when learned therefore, it is an example of rote rather than of representational learning Knowing about the two separate kinds of rote learning involved here helps one understand why rotely learned concept words that have been equated with rotely learned concepts have such little utility and are forgotten so quickly

VOCABULARY LEARNING AS MEANINGFUL LEARNING It is clear from the foregoing that vocabulary learning or the acquisition of word meanings is not regarded in this text as a manifestation of conditioning or rote verbal tional learning in that new meanings emerge after a potentially meaningful learning task is related to and interacts with relevant ideas in cognitive structure on a nonarbitrary and substantive basis In this case however, the learning task or potentially meaningful proposition consists of a composite idea and is expressed verbally in a sentence containing both denotative and connotative word meanings and the syntactic functions[3] of and relations between words The differentiated cognitive content resulting from the meaningful learning process and constituting its meaning is an interactional product of the *particular* way in which the content of the new proposition is related to the content of relevant established ideas in cognitive structure The relationship in question may be either subordinate superordinate or a combination of these two

Since cognitive structure itself tends to be hierarchically organized with respect to level of abstraction generality and inclusiveness the emergence of new propositional meanings most typically reflects a *subordinate* relationship of the new learning material to cognitive structure This involves the *subsumption* of potentially meaningful propositions under more inclusive and general ideas in existing cognitive structure The efficiency of subsumptive learning can probably be attributed to the fact that once subsuming ideas are themselves adequately established in cognitive structure they (a) have maximally specific and direct relevance for subsequent learning tasks (b) possess enough explanatory power to render otherwise arbitrary factual detail potentially meaningful (c) possess sufficient inherent stability to provide the firmest type of anchorage for newly learned detailed meanings[4] and (d) organize related new facts around a common theme thereby integrating the component elements of new knowledge both with each other and with existing knowledge

Sometimes the new propositional material is merely supportive of or directly derivable from an already established and more inclusive proposition in cognitive structure (*derivative* subsumption) as when one encounters statements illustrative of familiar precepts of Christianity or democracy More typically however new propositional meanings are acquired through a process of *correlative* subsumption The new learning material in this case is an extension elaboration modification or qualification of previously learned propositions This latter process is exemplified for example in subsuming unfamiliar Buddhist principles of virtue sin redemption and reincarnation under their Christian analogues

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[3] The learning of syntax itself and the apprehension of syntactic relationships will be discussed in later sections of this chapter

[4] The superior inherent stability of superordinate or inclusive ideas in cognitive structure is demonstrated by their greater resistance to forgetting over protracted time intervals as shown by qualitative analysis of subject matter forgetting

New learning material bears a *superordinate* relationship to cognitive structure when one learns an inclusive new proposition under which several established ideas may be subsumed. This type of propositional learning is relatively rare, since textbooks and teachers typically introduce more general and inclusive propositions first, and then present examples, corollaries, qualifications, extensions, elaborations, and so forth. Superordinate learning takes place in the course of inductive reasoning or when presented material is organized inductively or involves the synthesis of component ideas. (The acquisition of superordinate meanings occurs more commonly in *conceptual* than in propositional learning as, for example, when children learn that the familiar concepts of carrots, peas, beans, beets, and spinach may all be subsumed under the new term 'vegetable'.) Integrative reconciliation or synthesis of several apparently conflicting propositions under a more inclusive and unifying new principle is another example of superordinate learning.

The meaningful learning of new propositions that bear neither a subordinate nor a superordinate relationship to *particular* relevant ideas in cognitive structure, (that cannot be subsumed under particular established propositions or cannot themselves subsume particular established ideas), gives rise to *combinatorial* meanings. The learning of many new propositions, as well as concepts, yields this category of meaning. They are potentially meaningful because they consist of sensible combinations of previously learned ideas that can be nonarbitrarily related to a *broad background* of *generally* relevant content in cognitive structure by virtue of their *general congruence* with such content as a whole. Unlike subordinate or superordinate propositions, they are not relatable to *particular* relevant ideas within cognitive structure, and this availability of only generally and nonspecifically relevant content in cognitive structure presumably makes combinatorial propositions less relatable or anchorable to previously acquired knowledge and hence, at least initially, more difficult to learn and remember than subordinate or superordinate propositions. This latter inference follows directly from the previously described conditions of meaningful learning and from evidence indicating that the availability of appropriately relevant content in cognitive structure is a crucial variable in meaningful learning.

Most of the inclusive and broadly explanatory *new* generalizations that students learn in science, mathematics, social studies, and the humanities, for example, relationships between mass and energy, heat and volume, genic structure and variability, demand and price, are examples of combinatorial learnings. Although acquired with greater difficulty than subordinate or superordinate propositions, they manifest, once adequately established, the same inherent stability as any inclusive or superordinate (subsuming) idea in cognitive structure (see above). Further elaboration of these ideas typically results in subordinate learning (analysis, differentiation) and less commonly in superordinate learning (generalization, synthesis).

Since propositions can presumably be learned and retained most readily when they are subsumable under specifically relevant ideas in cognitive structure and since the hierarchical organization of cognitive structure is itself illustrative of the subsumptive principle it seems reasonable to suggest that the subsumptive mode of meaningful learning be utilized wherever possible This is the theoretical rationale for progressive differentiation in the presentation of subject matter and for the use of organizers

Some school learning that is frequently labeled rote learning (and which under many circumstances *is* purely rote) is actually intended to be a simple form of meaningful propositional learning as for example certain aspects of the learning of addition and multiplication facts It is true that some rote learning may be encouraged as a means of accelerating speed of response and calculation but in most modern schools the multiplication table for instance is learned *after* a clear understanding of number ideas and relationships is acquired Since this type of learning—relating pairs of numbers to their product—can be nonarbitrarily and substantively related to existing concepts of number relationships in cognitive structure it is hardly analogous to the rote learning of paired associates It is much more comparable to an actor s verbatim memorization of his lines after he acquires a meaningful grasp of their substance Learning sets therefore need not be purely rote or purely meaningful Learners may simultaneously or successively choose to learn both meaningfully and rotely

DISCOVERY LEARNING Propositional learning as described above is typical of the situation prevailing in reception learning when substantive propositions are *presented* to the learner and he is required only to learn and remember their meaning It is important to realize however that propositional learning is also a major type of verbal problem solving or discovery learning The main difference between propositional learning as found in reception learning situations on the one hand and in discovery learning situations on the other inheres in whether the principal content of what is to be learned is discovered by the learner himself or is presented to him In reception learning this content is presented to the learner in the form of a substantive or non problem setting proposition that he need only understand and remember In discovery learning on the other hand he must discover this content himself by generating propositions that represent either solutions to the problems that are set or successive steps in their solution

Actually the reception and discovery varieties of propositional learning are involved successively at different stages in the problem solving process To begin with problem solving propositions are not generated anew Their generation involves rather a transformation (restructuring reorganization synthesis integration) of relevant and available *substrate* propositions (propositions undergoing transformation) Substrate propositions in turn are of two main types (a) *problem setting* propositions defining the nature and conditions of the current problem situation and (b) *background* propositions consisting of relevant aspects of previously acquired knowledge (information principles) that bear on the problem

The meaningful learning of problem setting propositions in school and similar learning environments typically involves only reception learning [5] That is the propositions are presented to the learner and he need only learn and remember what they mean by relating them nonarbitrarily and substantively to his cognitive structure However unlike *substantive* reception learning situations that *end* with the learning and retention of the propositions in question the meaningful internalization of *problem setting* propositions sets in motion a discovery learning process A new problem solving proposition embodying a potentially meaningful means-end relationship is then generated through various transformation operations on the internalized problem setting and background propositions The final step in this meaningful learning sequence namely learning and retaining the meaning of the newly generated problem solving proposition is again a matter of meaningful reception learning In fact the only real discovery aspect of this entire sequence of meaningful propositional learning consists of the actual process of transforming the substrate propositions into a potentially meaningful problem solving proposition

Thus in meaningful discovery learning as opposed to the more typical (substantive) instances of meaningful reception learning the learner nonarbitrarily and substantively relates problem setting propositions to his cognitive structure—not for the purpose of understanding and remembering what they mean *as an end in itself* but for the purpose of transforming them (in conjunction with and with the benefit of previously acquired relevant background knowledge) into new problem solving propositions that are potentially meaningful to him

## Cognition versus Perception in Meaningful Verbal Learning

The distinction between perceptual and cognitive processes in meaningful verbal learning is particularly difficult to define because both kinds of processes involve interaction between verbal stimulus input and cognitive structure We both perceive verbal messages *and* cognitively learn their

[5] In more informal learning situations and in research laboratories (where discovery is genuinely autonomous) the learner himself formulates problem setting propositions through a preliminary type of discovery learning followed by meaningful reception learning of the products of discovery

meaning as a result of interpreting them in the light of existing knowledge The difference between the two processes is one of immediacy and complexity Perception involves an *immediate* content of awareness *before* the intervention of such complex cognitive processes as are even involved in reception learning Cognition involves such processes as relating the new material to relevant aspects of existing cognitive structure ascertaining how the resulting new meaning can be reconciled with established knowledge and recoding it in more familiar and idiosyncratic language

Hence if verbal meaning results when potentially meaningful verbal materials are related to and incorporated within existing cognitive structure (thereby generating new and differentiated cognitive content) and if this process of learning (acquiring) meanings is conceded to be *cognitive* in nature when and how in this sequence of events does *perception* play a role in meaningful verbal learning? Whether a given intellectual operation involves an immediate content of awareness (perception) on the one hand or more complex intellectual processes (cognition) on the other depends to a great extent on the complexity of the learning task relative to the learner s cognitive maturity and on whether the new material is first being learned or is *already* meaningful (Ausubel 1965b) Learning that particular auditory symbols (words) represent particular objects is a *cognitive* problem to a child learning the meanings of words Similarly understanding functionally the distinctive syntactic properties of words in a sentence is also a cognitive problem to the same child it presupposes both minimal mastery of the syntactic code and of the ability to apply such knowledge in syntactically decoding the sentence at hand Later on however when both the spoken words and the syntax are *already* thoroughly mastered the child is able to grasp their denotative meanings and syntactic functions on a purely *perceptual* basis This sequence of events with regard to cognition and perception is then repeated as he learns to *read* words and sentences in school In other words once the symbols spoken or written are encountered many times and become meaningful they become immediately and effortlessly (that is perceptually) apprehensible (meaningful) on subsequent encounters

The situation is somewhat more complicated in understanding propositions expressed in sentence form In this case the proposition itself is always a new learning task whose meaning remains to be acquired even if the meanings and syntactic functions of the component words are already known and can thus be apprehended (understood) perceptually The understanding of a sentence is thus a two stage process involving perception and cognition successively The first stage involves the perception of the potentially meaningful material and the second stage involves relating perceived potential meanings to relevant existing propositions in cognitive structure In the first stage the learner perceives what the message is or what he has to learn in the second stage he understands what he perceives that is he acquires its meaning Thus perception precedes cognition in the meaningful learning of new propositions The product of the perceptual process is not propositional meaning itself, but the immediate content of awareness that follows from preliminary interpretation of the *sensory* input (visual or aural) furnished by the potentially meaningful learning task This perceptual content of awareness is intermediate, both temporally and in terms of complexity of process, between primitive sensation and the actual emergence of meanings It consists of awareness both of the separate meanings of the component words and of the syntactic relations among them, but stops short of apprehension of the meaning of the propositional message as a whole

Hence, in order to understand a sentence, one must first be able (a) to perceive the potential propositional meaning it communicates, (understand the denotative meanings and the syntactical functions of its *component* words) and then (b) to incorporate this perceived potential meaning within existing cognitive structure The first step implies both adequate knowledge of vocabulary and a functional, if not a formal, grasp of syntax The second step implies relating the perceived proposition to relevant anchoring ideas in cognitive structure

It should be noted however, that repeated encounters with, or exposure to, the *same* potentially meaningful propositions change the above specified relationship between cognition and perception During the first encounter, the potentially meaningful message is first perceived, and the perceived content is then incorporated into cognitive structure to yield a corresponding meaning But once the message becomes meaningful, perhaps as early as on the second presentation, the two processes cognition and perception become telescoped into one That is as a result of the initial emergence of meaning and the concomitant change in cognitive structure, the learner becomes sensitized to the potential meaning in the message on subsequent encounters with it Its meaning having already been grasped the message no longer presents a cognitive problem it *immediately* (without the intervention of any cognitive processes) conveys actual rather than merely potential meaning when next perceived[6] Hence although the *acquisition* of meanings is a cognitive process it is proper to refer to the cognitive content evoked by an *already* meaningful proposition as a product of perception rather than of learning

To summarize once the syntactical code and a basic vocabulary are mastered the only cognitive aspects of understanding a sentence are asso-

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[6] Partly because of this telescoping effect (the immediate or perpetual emergence of meaning) repetition as will be pointed out later has a particularly consolidating effect on learning and retention the learner does not have to grasp meanings on subsequent trials and can concentrate solely on trying to remember them

group e rather than the original input events (G A Miller, 1956 pp 93 95)

Miller suggests that linguistic recoding is the most powerful device that human beings possess for extending the amount of information they can process and remember, and thus for acquiring large bodies of knowledge

Miller and J A Selfridge argue against the importance of meaning in learning by applying this type of information theory analysis to the problem of explaining why meaningless connected discourse is remembered better than strings of linguistically unconnected words and as well as meaningful prose In this instance, chunking is accomplished by grouping a series of words that are sequentially dependent on each other into larger units (phrases) and then remembering the phrases rather than individual words The recoding scheme under these circumstances is derived from the contextual constraints that characterize linguistically connected discourse and that are both built into the structure of language and implicitly learned by all those who use it These contextual constraints are defined in terms of dependent probabilities that is, the statistical dependency of the choice of a particular word upon the words that precede it, or the extent to which the choice of a given word is determined by the preceding words As degree of contextual constraint or order of approximation to English increases in a given sequence of words (see Table 2 for examples of such material), learning is progressively facilitated This is so because the message ' preserves the short range associations of the English language that are so familiar to us' (Miller and Selfridge 1950 p 183) and hence permits chunking or phrasing In fact when short range contextual dependencies are preserved in nonsense material the nonsense is as readily recalled as is meaningful material From this it is argued that contextual dependencies extending over five or six words permit positive transfer, and that it is these familiar dependencies rather than the meaning that facilitates learning (Miller and Selfridge, 1950 p 184)

It is evident from careful analysis of these findings however, that compensatory mechanisms such as chunking merely increase the learner s *rote* capacity for apprehending and retaining information For example, although Miller and Selfridge demonstrated unequivocally that nonsense material manifesting the same contextual constraints as potentially meaningful prose is recalled just as readily as meaningful prose, it is important to bear in mind that they demanded *verbatim* recall of the prose material Such verbatim or *rote* learning of potentially meaningful connected discourse obviously precludes all of the information processing and storing advantages of meaningful verbal learning it is superior (in the same way that the rote learning of connected *nonsense* material is also superior) to the rote learning of linguistically *unconnected* words solely because the sequen

TABLE 2
NONSENSE PROSE OF VARYING STATED DEGREES OF APPROXIMATION TO ENGLISH
*(Adapted from Miller and Selfridge, 1950)*

**0—order approximation**

byway consequence handsomely financier bent flux
cavalry swiftness weather beaten extent

**1—order approximation**

abilities with that beside I for waltz you the sewing

**2—order approximation**

*was he went to the newspaper is in deep red*

**3—order approximation**

tall and then boy is a biped is the beat

**4—order approximation**

Saw the football game will end at midnight on January

**5—order approximation**

they saw the play Saturday and sat down beside him

tial flow of the connected material conforms to the familiar contextual constraints of the language that make phrasing possible True meaningful learning on the other hand, presupposes *both* that the learning task is potentially meaningful and that the learner exhibit a meaningful learning set Thus, irrespective of how much potential meaning may inhere in a given passage of connected discourse, the material is still rotely learned as long as the learner's set is to assimilate it verbatim In short, because of their *rote learning set,* the subjects of this experiment never had a fair opportunity to demonstrate that *meaningful* learning of prose material is superior to the *rote* learning of linguistically connected nonsense

Consequently, one cannot apply Miller's conclusion that "it is these familiar dependencies rather than the meaning that facilitates learning to any situation other than the artificial one involved in verbatim or rote learning The acquisition of large bodies of knowledge is simply impossible in the absence of meaningful learning The connectedness of discourse, by making "chunking" ~~possible~~ undoubtedly facilitates learning and retention, but unless learning is also meaningful very little knowledge organized or otherwise can be assimilated

## Neobehavioristic Theories of Meaning

The foregoing account of meaning as the differentiated cognitive content elicited by particular symbols or groups of symbols and acquired as the end product of a meaningful learning process is commonly regarded as mentalistic by individuals subscribing to a neobehavioristic theoretical orientation in psychology However the term mentalistic although used opprobriously does not detract in any way from the theoretical cogency of this view of meaning—unless one assumes in advance the axiomatic validity of the behavioristic position A psychological theory has no need to be apologetic about assuming the existence of differentiated states of consciousness Nevertheless since this particular view of meaning is connected so intimately with the broader theory of meaningful verbal learning that constitutes the theoretical substructure of the book as a whole there is obviously some obligation to indicate more explicitly what advantages it has over leading alternative views

As one might reasonably anticipate most neobehaviorists do not identify meaning with a differentiated cognitive experience and the cognitive operations that give rise to such experience They conceive of it instead as the *implicit behavior* affective and motor elicited by a sign (Osgood Suci and Tannenbaum 1957) According to C E Osgood s mediational hypothesis the acquisition of meanings involves a conditioning process in which signs as a result of multiple contiguous presentations with their significates eventually come to elicit an implicit fractional portion of the total *response* evoked by the significates Signs in other words are said to represent significates because they evoke implicitly part of the total response made to significates and the meaning of a sign is therefore held to be coextensive with this implicit fractional response which Osgood calls a representational mediation process

### *Denotative versus Connotative Meaning*

The principal difficulty with the mediational theory is its inability to account for the *denotative* aspects of meaning The word dog for example elicits a sharply defined and precisely differentiated cognitive experience (meaning) embodying the distinctive or criterial attributes of dogs as distinguished from cats wolves human beings and other creatures At the very most a representational mediation process reflective of the most conditionable aspects of the total behavior instigated by dogs can identify the *attitudinal* and *affective* connotations of the word dog It cannot possibly define its denotative meaning[7] Despite the elicitation of markedly different implicit behavior or dispositions in persons who respectively fear cherish and despise dogs the word dog has the *same* denotative meaning for all three individuals that is it instigates substantially the same differentiated cognitive content These same implicit responses can also be elicited by *many other signs (for instance cat wolf ) which have very different de* notative meanings Thus the same sign can instigate quite different implicit (motor affective) responses consistent with the same denotative meaning and the same implicit responses can be elicited by signs with quite different denotative meanings It is clear therefore that an adequate theory of meaning must define the meaning of a symbol in terms of differentiated cognitive content and the psychological operations that determine such content even if this approach is opprobriously characterized as mentalistic by other theorists

Cognitive theorists concede of course that the *connotative* aspects of meaning can be plausibly conceptualized as a fractional implicit response largely *affective in nature In fact C K Staats and A W Staats (1957)* were able through simple conditioning procedures to invest nonsense syllables with the connotative meanings of already meaningful words However by any standard the more crucial and distinctive aspect of the acquisition of meaning is denotative in *nature and this aspect of the meaning phenom* enon can hardly be explained by invoking the same mechanism that accounts for the connotative attributes of words

Osgood s mediational theory of meaning has been broadened recently by both O H Mowrer (1960) and A W Staats (1961) to include conditioned sensory responses The word apple according to Mowrer not only carries the implication of something liked or disliked but also of an object with certain purely sensory qualities (Mowrer 1960 p 164) On the positive side this modified mediational view approaches the cognitive position inasmuch as it maintains that words (conditioned stimuli) represent objects by virtue of eliciting part of the same cognitive content (images or conditioned sensory responses) evoked by the objects Once the carrier of meaning is thus identified with substantive conscious content (images) rather than with implicit behavior an adequate basis is established for the differentiated aspects of denotative meaning Nevertheless significant theoretical

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7 Under certain conditions of course attitudinal and affective elements may become part of denotative meaning For example in three different cultures where dogs are respectively sacred abhorrent and economically indispensable it is con*ceivable that the* associated relevant attitudes and feelings may become incorporated into conceptual content Under these circumstances however they actually constitute distinctive defining attributes of the concept rather than correlated attitudes

difficulties still remain In the first place it strains credulity to conceive of the cognitive content evoked by a sign or a significate as a sensory *response* If conscious experience must be equated phenomenologically with motor and glandular responses to fit cognitive events into the stimulus-response paradigm only pseudo-rapprochment is achieved between the neobehavior istic and cognitive positions Second as we shall see shortly the mechanism whereby meanings are acquired is not really very analogous to conditioning

### *The Problem of Representation*

A second related difficulty on which mediational theories of meaning tend to founder concerns the very nature of symbolic representation The very essence of a representational symbol is that although it does not re semble its referent in any way it signifies the same thing that the latter does after representational learning occurs According to the mediational view however words represent things because they produce in human beings some replica of the actual *behavior* toward these things as a mediation process (Osgood Suci and Tannenbaum 1957 p 7) But the fact that a given symbol evokes an implicit affective or motor response that is a frac tional part of the total response that its referent elicits does not imply in any way that the symbol actually *signifies* to the reacting individual what the referent does In the first place what anything significate or symbol primarily signifies to a person who knows it is the objective explicit sharply defined and distinctive content of awareness it induces in him—in short the kind of awareness that enables him to distinguish it (referent or symbol) from other things There is no signification without this special kind of awareness

*Implicit* affective or motor behavior however is either not accompanied by any awareness whatsoever or is accompanied by awareness that is typ ically vague subjective poorly defined and nondistinctive Further what something signifies to a person and what he does or feels about the thing signified are related but by no means identical phenomena He may not respond to it at all either affectively or skeletally and if he does respond the response can hardly be considered distinctive of what the particular significate or symbol signifies to him All of this of course is just another and more explicit way both of saying that what representational symbols signify is essentially denotative in nature and of explaining why this is the case

Second implicit in the very concept of a representational symbol is the notion that the person who knows what it means appreciates its repre sentational character and function that is appreciates that it *signifies* the same thing that the referent does but actually *is* not the same thing How ever if a symbol merely serves as a conditioned stimulus that is if through conditioning it acquires the power to elicit part of the same response that the unconditioned or originally adequate stimulus (the significate) does thereby developing a capability it did not originally possess, it does not, as a result of this process, *represent* the significate but simply becomes an *adequate stimulus in its own right*, the conditioned individual, in other words, responds to the symbol as if it *were* the significate and has no appreciation whatsoever of its representational character Indispensable, therefore, to the concept of symbolic representation is some degree of appreciation on the part of the individual who knows what a particular symbol means, that the pattern of stimulation constituting the symbol is not the same pattern of stimulation constituting its significate

### *Conditioning or Cognitive Process*

Finally, it is evident that the use of the conditioning paradigm to explain the process whereby representational meaning is acquired constitutes an unwarranted extension of principles that are valid for certain simple kinds of learning to a more complex and qualitatively different kind of learning This is particularly unfortunate when a more satisfactory explanation is available

There are at least three good empirically grounded reasons for believing that the previous description of representational learning as an active *cognitive* process, exemplifying the basic features of meaningful learning, is more tenable than the conditioning explanation favored by mediational theorists (a) Human beings generally, apparently even in early childhood and unquestionably afterward, understand that everything has a name and that any given name signifies the same things that its referent does It would certainly be remarkable if this general insight were not put to good use in learning the meanings of particular symbols—if the learning of all particular word meanings did not involve some nonarbitrary reference to, and facilitation by the presence of this stable generalization in cognitive structure (b) In acquiring word meanings learners give every indication of consciously and actively equating word and referent in meaning They are also well aware of the fact that although symbol and significate signify the same things, each consists of an entirely different pattern of stimulation (c) Even very young children can learn word meanings and retain them for days and often weeks at a time after only a single pairing of word and significate These facts are wholly incompatible with either a conditioning or rote learning explanation of acquiring word meanings but are entirely consistent with the available evidence regarding meaningful learning

The cognitive interpretation of the acquisition of meanings conflicts in no way with the empirical fact that signs like any conditioned stimuli, may *automatically* elicit conditioned *responses* This latter phenomenon, as we have seen previously, probably accounts in part for the connotative meaning of words Hence, in the acquisition of meanings, the *same* sign can become both a conditioned stimulus for the implicit affective responses associated with connotative meaning and a representational equivalent of concrete images or of more abstract cognitive content (denotative meaning). Contiguity in time between symbol and significate is an essential condition for learning each type of meaning, but plays a different role in the acquisition of representational equivalence or denotative meaning (meaningful learning) than in the acquisition of connotative meaning (conditioning).

### Other Neobehavioristic Views

Not all neobehaviorists, of course, embrace a mediational concept of meaning. B. F. Skinner (1957), for example, handles verbal behavior as simply a linguistic variety of emitted response which can be brought under stimulus control through differential reinforcement, and explicitly denies that the concept of meaning is necessary or useful in explaining such behavior. He is completely unconcerned with the problem of whether an emitted verbal response represents the stimulus that come to elicit it, and hence with the problem of how verbal representation is learned. The problem of how meaning is learned is thus solved by denying that meaning exists; at the same time, however, the most significant aspect of learning and cognition at the human level is arbitrarily ruled out of existence.

W. A. Bousfield (1961) adopts a somewhat related position in maintaining that the meaning of a word to a given individual is nothing more than his particular pattern of verbal associations with that term. This view, however, is at the very least vulnerable to the obvious criticism that the verbal associations a word evokes do not define its denotative meaning. One of the commonest verbal associations with any term, after all, is its semantic opposite.

The view that the learning of word meanings is comparable to the rote learning of paired associates—the significate constituting one term of the pair and its corresponding symbol constituting the other term—is widely held but does not warrant separate consideration. All of the difficulties ascribed to the conditioning explanation of the learning process also apply to this view.

### Propositional Meaning

It is in trying to explain how we acquire the meanings engendered by relating ideas to each other that neobehaviorists encounter their greatest difficulty. The only explanation they can offer to account for the acquisition of propositional meaning is that the meaning responses of subject and predicate are reciprocally conditioned to each other (Mowrer, 1954, 1960). One obvious difficulty with this view is that the conditioning paradigm cannot possibly explain the semantic information conveyed by the syntactic functions of words in a sentence Most propositions are both logically and syntactically much more complicated with respect to the subject predicate relationship *than* O H *Mowrer s paradigm example of Tom is a thief* would have us believe For example on the basis of simple contiguity and conditioning principles alone John hits Mary and Mary hits John should elicit identical meanings

Even more important is the fact that in understanding the meaning of Tom is a thief one is doing much more in a cognitive sense than merely *conditioning the meaning response of thief to the subject Tom* We have already considered the shortcomings of the conditioning mechanism in explaining the acquisition of word meanings In addition it seems much more plausible to suppose that a specific proposition of this nature derives its meaning from the fact that it can be subsumed as an examplar under the *more general existing proposition in cognitive structure that any* particular individual may be a thief Further as already pointed out most propositions bear a much more complex relationship to established ideas in cognitive structure and also involve the perception of much more complex syntactic relationships between the component words of a sentence than does Mowrer s example

## Acquiring *Meanings*
## Informal Learning of Syntax

Linguistically speaking *grammar consists in large part of the particular* set of syntactic rules that are generally accepted by the users of a language for inflecting words and combining them into sentences It is in effect a syntactic code consisting among other things of (a) connecting words (prepositions conjunctions) (b) designative words (articles demonstrative adjectives) (c) inflections indicating number gender person case tense mode and mood and (d) word order rules adding relational meaning to connected discourse From a psychological standpoint however syntactical rules *primarily serve the transactional* function of bringing verbally expressed ideas (images and concepts) into relationship with each other in a reliable fashion for the purpose of generating and understanding new ideas Hence when a group of words are appropriately inflected and combined according to the designated rules the resulting sequence is not only grammatically correct but also communicates the idea that the speaker or writer intends to convey Typically therefore a given word in a sentence both conveys a distinctive denotative meaning and by virtue of its particular syntactical function in the sentence (subject object verb) furnishes additional *semantic information* that contributes to the understanding of propositional meaning As a matter of fact one often needs to know the syntactical function of a word before its denotative meaning can be apprehended as in the case of words of different meaning that sound alike or of certain words that can serve as both nouns and verbs

The principal psychological problems with respect to grammar, then are to specify the cognitive processes involved in generating and understanding sentences and to discover how children learn to identify and appropriately use different syntactic categories Selected aspects of the first problem has already been discussed in some detail earlier in this chapter The second problem will be considered briefly below

The informal learning of syntax is a gradual and extended learning process that is comparable to other forms of meaningful learning and retention In this case however the structure of the language itself is the learning task or object of learning The grammar used by young children is obviously different from that of adults but nevertheless manifests a distinctive structure of its own at each particular stage—a structure that is related in some "reduced" fashion to the adult structure from which it is derived (Brown and Fraser, 1963) A complete psychological analysis of the successive syntactic structures that evolve during early childhood would require specification of the cognitive processes involved of the relevant variables influencing these processes and of the role played by general characteristics of the prevailing stage of cognitive development But since the informal acquisition of syntax is generally completed about two years before children enter school detailed analysis along these lines is obviously beyond the scope of a textbook in educational psychology in any case, the various stages in the acquisition of syntax are still not completely understood[8] It may be noted however that functional mastery of the syntactic code of one's native language is acquired *inductively* through extensive practice in decoding the meaning of sentences. Hence once the code is mastered at various levels of sophistication there is really little further problem of applying such knowledge either in understanding (decoding) sentences or in generating (encoding) them potential meaning to cognitive structure so as to comprehend it The beginning reader who is already able to perceive the potential meaning in *spoken* messages must now acquire the same ability in relation to written messages Because the denotative meanings and syntactic functions of the component words he will encounter are *already* known to him in their corresponding spoken forms learning to read obviously constitutes a less significant cognitive accomplishment than the original learning of the spoken language In other words the beginning reader is not really learning a *completely new* symbolic code but rather a written equivalent of a familiar spoken code whose basic vocabulary and syntax he has already mastered

The most salient psychological characteristic of learning to read therefore is the dependence of the learning process on the previously acquired *mastery of the spoken language and on the use of this mastery as a medium* for perceiving the potential meaning in written messages In fact the child learns to read his native language by reconstructing written into spoken messages He tries to establish representational equivalence between new written words and their already meaningful spoken counterparts In view of this important mediating function of the spoken language in learning to decipher the meaning of written messages it is theoretically indefensible to teach reading by seeking to establish *direct* equivalences between the new visual symbols and their significates (objects or pictures)

Learning to reconstruct written into spoken messages involves at least two major component steps First there is the problem of converting written words into spoken words This problem is rendered less difficult however by the alphabetic basis of structuring most written languages Thus *written words are not just configurations of visual symbols that arbitrarily* represent their auditory counterparts Rather there is a more or less lawful relationship between the combination of distinguishable sounds (phonemes) constituting the spoken word and the analogous combination of letters (graphemes) constituting the corresponding written word The beginning reader must therefore learn how to convert graphemes and combinations of graphemes into their phonemic equivalents and then learn how to coalesce several graphemic combinations and reconstruct them into spoken words In this latter process of word recognition he is aided by such cues as knowledge of commonly occurring graphemic combinations (*prefixes and suffixes*) and awareness of the wider context in which the written message is presented

The second step in reconstructing the written message is learning how to combine and convert groups of written words into spoken phrases and sentences By doing this knowledge of the syntactic code of the spoken language can be utilized in perceiving the potential meaning of the written message The beginning reader in other words is unable to apprehend *directly the syntactic functions of the words in the written message in* order to perceive its potential propositional meaning therefore he recon reading (that is prior emphasis on letter recognition and grapheme phoneme correspondences before actual reading practice) makes more psychological sense than teaching children to recognize words as wholes from the outset (the look say method) The phonetic approach makes the problem of word recognition less arbitrary by giving the child a lawful code with which to reconstruct currently meaningless but potentially meaningful written words into their already meaningful spoken equivalents Word recognition thus becomes more a matter of rational problem solving than of random guessing that is it becomes a process of lawfully decoding the unknown written word by applying existing knowledge of grapheme phoneme correspondences with the aid of such additional cues as context The look say method on the other hand renders written English based for the most part on regular and learnable correspondences between graphemes and phonemes into a pictorial nonalphabetic written language like Chinese It is true of course that children who learn to read by the look say method tend spontaneously to develop some impressions about grapheme phoneme correspondence and to use these impressions in deciphering unfamiliar words But this haphazard incidental and unguided discovery learning of grapheme phoneme correspondence can hardly be considered a defensible instructional procedure when such knowledge can be transmitted much more efficiently on a systematic suitably programmed and guided reception basis

The use of an augmented Roman alphabet in teaching reading (Pitman 1961) now in the experimental stage represents a further attempt to capitalize on grapheme phoneme correspondences in helping children to derive meaning from written messages This method seeks to overcome the ambiguities and inconsistencies inherent in the fact that some English graphemes particularly vowels have several phonemic equivalents It accomplishes this aim by using instructional materials based on an alphabet of 46 graphemes one for each recognizable phoneme in the English language Yet once children acquire initial facility in reading materials written in the augmented alphabet they apparently experience little difficulty in reading text employing the conventional alphabet (Sebesta 1964) This is not so surprising however when one considers that the use of supplementary cues to simplify the learning process during early stages of acquiring a new cognitive skill does not necessarily create dependence on these same cues after the skill is partially acquired The beginning reader is much better equipped to cope with irregularities in grapheme phoneme correspondence after mastering the regularities and acquiring a basic vocabulary of written words

The learning of grapheme phoneme correspondences does not imply that pupils must learn a set of formal rules This would hardly be practicable at the age of initial reading instruction Rather it means providing guided practice in responding phonically to the more frequently encountered letter combinations in words so that the child acquires an intuitive grasp of grapheme phoneme correspondence He thus eventually becomes capable of responding automatically with the correct phonemic equivalents of the different graphemes and graphemic combinations

Wholistic methods of teaching reading are sometimes defended on the grounds that mature readers perceive whole words and even phrases at a time rather than individual letters or syllables This of course is true but totally irrelevant to the point at issue What applies to skilled readers does not necessarily apply to pupils who are first learning to read The techniques employed by an expert in performing a complex skill can hardly be recom mended as suitable practice exercises for the novice The beginning student of Morse code for example thinks in terms of letter units not in terms of larger word and phrase units characterizing the transmitting and receiving operations of the skilled telegraphist

Finally it is important to bear in mind that phonetic and wholistic approaches need not be mutually exclusive procedures either in theory or in practice Advocates of the phonetic method ordinarily teach whole word recognition of some of the more common words as a means of making possible earlier reading of simple meaningful text and of thereby enhanc ing the beginning reader s interest self-confidence and motivation and look say advocates typically introduce varying degrees of phonic analysis *after* their pupils acquire some reading fluency The difference between the two schools of thought today is largely one of timing and relative emphasis Nevertheless this difference is still important both theoretically and practi cally and although definitive empirical evidence is still lacking the argu ments of the phonetic school in our opinion rest on theoretically more tenable ground

## Acquiring Meanings
## Second Language Learning

Learning a foreign language consists fundamentally in the acquisition of an *a l litional set of symbols* for old familiar meanings according to W Bernard Just as we learn to read by establishing representational equiva lence between new written symbols and familiar already meaningful spoken symbols and by reconstructing written into spoken messages so we learn a new language by establishing representational equivalence between new foreign language symbols (both spoken and written) and their already meaningful native language counterparts and by reconstructing foreign language into native language messages It is evident therefore that the second language learner is in a much different psychological position from that of the native language learner In the first place he has already mastered the basic vocabulary and the syntactic code of one language Second, he is generally able to read this latter language Lastly, he is capable of com prehending and applying formally stated syntactical propositions Thus ' the learner approaches the second language with the mechanism of a first language already fixed in his thought and speech, and he is by no means expected to discard or even neglect his native tongue" (W Bernard, 1951, p 89)

### *The Audiolingual Approach*

The great popularity of audiolingual methods in second language learn ing today is more than just an over reaction to previous pedagogic techniques that concentrated almost exclusively on reading, translation, and composi tion skills and neglected oral comprehension and speaking ability In part, it *is also a reflection of the widespread cultural belief that, because children* learn language the "natural" (audiolingual) way, and are apparently much more successful in this enterprise than are older learners who are subjected to more formal reading and grammatical instructional procedures, the audiolingual approach must obviously be the most effective method of ac quiring new languages, and should be used by older learners in second language learning

This line of argument, in our opinion, is vulnerable on two counts In the first place, on either research or theoretical grounds, it is difficult to sub stantiate the thesis that children, in learning a native or second language, are, in fact, superior to adolescents and adults in learning second languages Second even if this were the case, there would still be no good reason for believing that methods which yield satisfactory results with children must necessarily be appropriate for adults These latter methods are used, after all, not because they are demonstrably more efficacious under *all* conditions, but because children's cognitive immaturity and lack of certain intellectual *skills preclude many approaches that are feasible for older age groups.*

Naturalness is a slippery argument because what is natural for one age group is not necessarily natural for another The point about naturalness would be tenable only if the respective cognitive equipment of second language and native language learners were comparable Since this is not the case, however, what is natural for one learner is quite unnatural for the other Because of the aforementioned highly significant changes in cogni tive readiness that take place as a result of the learner s mastery of his native language, certain features of the audiolingual approach are psychologically incompatible with effective learning processes in adults These features in clude (a) ' direct ' learning of second language meanings and syntactical functions that is, avoidance of the mediational role of the native language, (b) rote learning of phrases, (c) inductive rather than deductive learning of grammatical generalizations (d) presentation of the spoken form of the language before the written form and (e) insistence on exposing the beginner to the natural speed rendition of the spoken language (Ausubel 1964a)

AVOIDANCE OF THE NATIVE LANGUAGE The audiolingual method seeks in all possible ways to avoid the mediating role of the native language in second language learning It attempts to accomplish this objective through the rote learning of phrases and through the inductive learning of syntactic rules through direct association of second language words and phrases with objects pictures and situations rather than with native language words by giving second language instruction in the target language itself and by proscribing translation practice

Actually it is both unrealistic and inefficient for the learner to try to circumvent the mediating role of his native language when learning a second language In the first place after early childhood even the

> greater part of our own language is learned not by the direct method i e not by the direct association of words and things but *indirectly* through old known symbols e g by way of synonyms, antonyms definition or context in speech or reading matter Hence it is clear that the direct association of [new] symbols with their respective objects is of necessity totally inadequate for the learning of a new language Indeed even where the possibility is offered for a direct association between the new symbol and the object the old symbols at first always involuntarily intervene (W Bernard 1951 pp 91 92)

In addition it is important to recognize that we learn the new syntactic code by using native language syntax as a model and then noting similarities and differences between the two codes This type of analysis is also best conducted in the native language Thus numerous aspects of first language knowledge—the meanings of most concepts the understanding of syntactical categories and functions facility in using many structural patterns that are nearly identical in the two languages—are directly transferable to second language learning It would therefore be not only impracticable but also impossible not to make use of this knowledge in acquiring the second language

Avoidance of the mediating function of the student s native language in second language learning is customarily justified on two grounds First it is argued that children do not learn their native language through the mediation of another language This argument however is completely beside the point because the native language learner does not possess another set of meaningful symbols and hence could not avail himself of their mediating influence even if he wanted to When such a set is available however it is unrealistic not to make use of it irrespective of whether the new task is learning to read or learning a second language Second it is pointed out that the truly bilingual individual thinks directly in the second language rather than translating from his native tongue It must be realized however, that al though this latter state of affairs is generally true it is a reflection of a *terminal* state of second language proficiency and does not describe the *learning situation when the bilingual individual is a beginning student*

What is usually lost sight of by those who argue for the direct method and for immediate direct reading is that *to grasp the thought directly from the written* page without the intervention of the mother tongue presents already an *advanced stage* of achievement and that the fundamental thing is *first to learn the meaning of the numerous individual words or phrases that constitute the page There is the* obvious confusion here of the means with the end of the immediate with the ulti mate objective True we want our students to read the foreign language directly *and fluently* with the least possible interference from the mother tongue But this is, or ought to be the *final result*, the goal and aim of our teaching and not necessarily the means of achieving it How can we expect learners to read a foreign language directly and fluently when this is the *very thing* we expect them to acquire *as a result* of our teaching (W Bernard 1951 p 95)[9]

ROTE LEARNING OF PHRASES *Because young children are explicitly un* aware of syntactic functions and categories it is often assumed that their language capability consists of *rote verbal habits* Actually, however, the ability to understand and generate sentences implies even in children a meaningful learning process in which there is at least some implicit aware ness of the denotative and syntactical contributions of component words to the total meaning of the sentence In older learners this awareness particu larly in second language learning, exists on a much more explicit and abstract basis *and hence meaningful learning is an even more important* considera tion in teaching them than in teaching children

The audiolingual approach, however, tends to assume that second lan guage learning both in children and adults is largely a process of rote verbal learning Both in pattern practice drills and memorized dialogue practice[10] there is either no awareness of phrase meaning whatsoever or, at the very best awareness of *total* phrase meaning Thus the learner understands neither the syntactic functions of the component words nor the denotative and syntactical contributions of the *individual* words to the total meaning of the phrase A purely arbitrary (rote) rather than lawful or meaningful rela tionship prevails between phrase meaning and component elements of the phrase

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10 Pattern practice drills consist of practice in repeating phrases illustrative of a particular grammatical construction and in making simple substitutions and transformations in such phrases that further exemplify the same construction with only slight changes in meaning In memorized dialogue practice students rotely learn and practice the phrases they use in carrying on a conversation

Under these circumstances it is hardly surprising that particular grammatical patterns can be emitted perfectly in a familiar and structurally limited context or that simple substitutions, transformations and elaborations can be made but that new words in a wider, unfamiliar context cannot be fitted into the learned pattern, or that the same words and syntactical categories cannot be recombined in different patterns to express different ideas In contrast, the principal transferable objective which truly *meaningful* pattern practice should aim to achieve is precise knowledge of the syntactical function of each word and of its semantic contribution to total phrase meaning When the learner manifests this knowledge, it is possible for him (a) to construct a structurally comparable phrase expressive of an entirely different idea in which each component word bears a syntactical relationship to total phrase meaning that is analogous to the set of relationships prevailing between component words and total phrase meaning in the learned model phrase, and (b) to recombine familiar words and known syntactic functions in the learning of new grammatical patterns

The remedy, therefore is not to eliminate pattern practice drills but to make them more meaningful Second language learning obviously requires overlearning of the basic and characteristic structural patterns of the language But unless the learner appreciates the precise relationship between the verbal manipulations he practices and the changes in meaning that he induces by such manipulation the practice is not very transferable

INDUCTIVE LEARNING OF GRAMMATICAL RULES Pattern practice drills seek to duplicate in second language learning the process whereby children attain syntactical mastery of their native language What is primarily striven for is a functional intuitive grasp of syntax after inducing much manipulative experience with the major structural patterns of the language Grammatical generalizations are provided, if at all, only after the principles in question are acquired on an inductive intuitive basis and are rendered virtually automatic

Young children of course, *have* to learn syntactical rules through an inductive process of discovering various linguistic regularities in the multiform language patterns to which they are repetitively exposed Grammatical generalizations would make absolutely no sense whatsoever to them since they are manifestly incapable of understanding complex relationships between abstractions This type of discovery learning however, is exceedingly wasteful and unnecessary when we deal with older learners who are perfectly capable of comprehending abstract syntactic propositions It takes a long time to discover grammatical rules autonomously and inductively, and until the correct discovery is made practice is not transferable Furthermore, as long as these rules are known only intuitively and implicitly their transfer ability to comparable situations is restricted to what is analogically quite similar and obvious

Deductive use of grammatical generalizations, on the other hand, is decidedly more efficient in second language learning No time is wasted in discovery, and both the generalization and the experience of applying it to appropriate exemplars are transferable from the very beginning of practice As a precisely, explicitly, and abstractly stated proposition, a grammatical generalization also has wider transferability to new situations

PRIOR PRESENTATION OF MATERIALS IN SPOKEN FORM A cardinal principle of the audiolingual approach is that instructional materials should be presented in their spoken form before they are presented in their written form and that listening and speaking skills should be acquired before reading and writing skills

The major rationale offered for this order of skill acquisition is that it is the 'natural' order in which children learn their native language But because a child *has* to learn how to speak and understand his native tongue before he can read it, it does not necessarily follow that once he knows how to read he has to observe the same sequence of events in learning a second language Once any new skill such as reading is learned it can obviously be used as a tool in acquiring new knowledge It is unnatural to expect that after an individual becomes literate he will learn in the same way as when he was illiterate

A second reason for advocating this order of learning is the belief that it can lead to direct reading in the second language It is maintained that if various items of second language material can be understood and spoken they can also be read without any explicit practice in reading as such This would have the additional presumed advantage of avoiding any tendency to translate the material as it was being read The available research evidence (Agard and Dunkel 1948) indicates however, that audiolingual and reading skills are separate and independently developed capabilities Although practice in one is partly transferable to the other especially at higher levels of proficiency considerable specific training in each skill is required for the acquisition of competence [11]

Still a third reason for advocating prior presentation of materials in spoken form is the possibility that the written form of the second language

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[11] Evidence from the same investigation indicates that the audiolingual approach also fails to accomplish its other principal objective namely to enable students to acquire higher levels of speaking and oral comprehension skills than are customarily acquired in conventional foreign language courses In a more recent and better controlled study however G A Scherer and M Wertheimer (1964) found that the audiolingual method does enhance ability to speak and think in German although traditionally trained students are superior in writing skills and in translating from German into English No lasting differences were found in reading and listening skills or in ability to translate from English into German

will generate phonological interference from the native language because the same graphemes often have different phonemic values. On the other hand, it can be plausibly argued that the individual sooner or later has to learn to associate graphemes in the second language with their phonemic equivalents, and that he may as well confront this first language interference and learn to overcome it from the very beginning.[12]

Turning now to the other side of the argument, two defensible reasons can be advanced for presenting written and spoken materials in the second language both alternately and concomitantly. First, in our culture, adolescents and adults are habituated to learning most new ideas and subject-matter content by reading rather than by listening. Thus a pure audiolingual approach deprives the older learner of his principal learning tool and of the instructional medium in which he feels most comfortable and confident. This is particularly unfortunate during the early phases of instruction when learning stresses tend to be greatest.

Second, prior familiarization with and simultaneous exposure to the written form of the material can serve as helpful props in the early stages of acquiring oral comprehension skills. Because of unfamiliarity with new sounds, with atypical sequences of sounds, and with the characteristic word order and syntactical patterns of the second language, it is very difficult for the beginner to distinguish individual words, inflectional forms, and groups of words from listening alone. Hence, he often fails not only to grasp the meaning of the spoken material, but also to appreciate its syntactical structure well enough for purposes of transfer. Simultaneous reading can furnish the necessary cues for meaning and grasp of syntactic structure while listening skills are being developed. As oral comprehension increases, particular passages can be omitted in the written lesson and eventually the written material will not be needed at all.

NATURAL SPEED RENDITION" OF THE SPOKEN LANGUAGE. In the audiolingual approach, beginners are typically exposed to the "natural speed rendition" of the spoken language—presumably to accustom them to the "natural rhythm" of the language. It is pointed out that children eventually learn to understand their native tongue under comparable circumstances. In terms of gain per unit of learning time, however, it should be self-evident that practice in listening improves oral comprehension ability primarily insofar as what is heard is also understood. Thus, if the sample of speech to which the learner listens is too rapid for him to understand, it does little to en-

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[12] The only direct evidence bearing on this issue is a study by Pyper (1964) indicating that oral pre-practice with various phonemic sequences in beginning Spanish prior to the presentation of written materials, does *not* significantly enhance initial pronunciation ability.

hance his ability to comprehend the spoken language Furthermore, even if he is able to understand the material in a general way, he may still not be able to distinguish the major structural patterns well enough to transfer them to speaking and other listening situations

Hence, since learning to comprehend the spoken language is a very gradual process, it should undoubtedly be assisted in the beginning by means of a slower rate of speech that is progressively accelerated as oral com prehension improves Artificial simplification is always justifiable during the early stages of any learning process When any given passage of material is presented to the beginner, he can, of course, be exposed to a slowed down version and then to a normal speed rendition

## Language and Cognitive Functioning

Although preverbal cognitive functioning does exist and characterizes the behavior and thought of infrahuman organisms and of young children, *it plays a relatively minor role in school learning For all practical purposes,* the acquisition of subject matter knowledge depends on verbal and other forms of symbolic learning In fact, it is largely because of language and symbolization that most complex forms of cognitive functioning become possible

> Translation of experience into symbolic form, with its attendant means of achieving remote reference transformation and combination opens up realms of *intellectual possibility that are orders of magnitude beyond the most powerful* image forming system Once the child has succeeded in internalizing language as a cognitive instrument it becomes possible for him to represent and systematically transform the regularities of experience with greater power and flexibility than before (*Bruner* 1964a *pp* 13 14)

Evidence from various sources indicates that somewhere between the fourth and fifth years of life, language assumes a dominant role in cognitive functioning A R Luria (1959) has shown that the internalization" of speech at this age (that is, the ability of the child to manifest speech on a nonvocal and noncommunicative basis) coincides with the emergence of language as the principal directive factor in instigating, controlling, and organizing behavior The same shift from stimulus to verbal cognitive con trol of behavior is exhibited in discrimination learning ( T S Kendler, 1963) and in the ability to transpose a learned relationship to an analogous pair of stimuli (Kuenne, 1946, Alberts and Ehrenfreund, 1951) For example, *after the ' verbal child learns to choose the larger member of a pair of two* blocks, he can transfer this learned relationship to similar pairs of *any* absolute size Experimental findings in discrimination learning (Kendler and Kendler, 1961, Spiker, 1963), transposition learning (Spiker and Terrell,

1955) and concept formation (Lacey, 1961, Weir and Stevenson, 1959) suggest that the superiority of verbal learning to preverbal cognitive functioning is attributable to the fact that symbolic learnings can be identified, transformed and differentially responded to much more efficiently than can the stimuli or situations represented by the symbols [13] Finally, by this age the child has also mastered the syntax of language sufficiently well to understand and generate fairly complex propositional statements

Parallel analysis of the development of language and thought (Inhelder and Piaget, 1958 Vygotsky 1962) also suggests that growth in logical thinking is in large measure tied to growth in language capability On purely theoretical grounds it would be difficult indeed to deny some degree of causal relationship between such linguistic developments as symbolical representation the mastery of syntax the internalization of language, and the acquisition of more abstract and relational terms on the one hand, and such developments in cognitive functioning as the internalization of logical operations emergence of the ability to understand and manipulate relationships between abstractions without the benefit of current or recent concrete empirical experience and attainment of the capacity to think in terms of hypothetical relations between variables on the other hand (see Chapter 5)

Much of the failure to appreciate the important facilitative role of language in cognitive functioning is of course a reflection of the view popularized by the progressive education movement that verbal learning necessarily consists of rotely memorized glib verbalisms In large part however it also *reflects confusion between the labeling and process functions of language* G Hendrix for example argues that in the natural order of events the abstraction comes first and *then* a name for it is invented (Hendrix 1950 p 335) According to her the understanding and discovery of ideas is completely a subverbal internal process the *entire* substance of an idea purportedy inheres in subverbal insight Language only enters the picture because of the need to attach a symbol or label to the emerging subverbal insight so that it can be recorded verified classified and communicated to others Verbalization she asserts further (1947) is not only unnecessary for the generation and transfer of ideas and understanding but is also positively harmful when used for *these* purposes The resulting problem then becomes one of how to plan and execute teaching so that language

[13] As we shall see later (Chapters 4 and 14) in discussing the relevant research verbalization is an important factor in transferring learned principles to new problem solving situations even those of a motor or mechanical nature These findings challenge the widely accepted tenet of progressive education that verbal learning is necessarily rote in character and that only nonrepresentational experience is transferable from one problem solving situation to another

and precision—the level of abstraction that could be achieved if concepts were unnamed The naming of ideas therefore is a significant *prerequisite* for their later *use* in conceptualization and other forms of thinking except of course in the case of generating new concepts and propositions at a very low level of abstraction

Second language plays an important role in verbalizing or encoding into sentences the new intuitive or subverbal product (concept or proposition) that emerges from the transformational operations involved in thinking Verbalizing subverbal ideas (*expressing* them verbally in propositional form as opposed to the later act of *naming* them) is a refining process that results in their becoming much clearer more explicit more precise and more sharply delineated It is therefore a serious mistake to believe that the *entire* substance of an idea as well as *all* of its transfer power inheres in its subverbal form as Hendrix asserts (1950) The old philosophical notion that verbalization merely mirrors thought or clothes it in outer garments is charmingly poetic but has little psychological utility or explanatory value today By means of its significant refining functions verbalization adds a great deal both to the meaning and transferability of the products of thought and thus must be considered an integral part of the process of thinking

In conclusion therefore it can be stated that language contributes in two important ways to concept formation and problem solving First the representational properties of words facilitate the transformational processes involved in thought Second, verbalization of the emerging subverbal products of these operations prior to naming them refines and enhances their meanings and thereby increases their transfer power In a larger sense however acquisition of language also enables developing human beings to acquire through reception learning and to use in discovery learning a vast repertoire of concepts and principles they could never discover by themselves in their own lifetimes This is the case because the human capacity for representational symbolism and verbalization make possible both (a) the *original* generation (discovery) of ideas at a uniquely high level of abstraction generality and precision and (b) the cumulation and transmission of these ideas during the course of cultural history The scope and complexity of the ideas acquired through reception learning make possible and foster in turn a level of individual cognitive development that would be utterly inconceivable in the absence of language

Chapter 3

# MEANINGFUL RECEPTION LEARNING AND RETENTION

NOW THAT THE NATURE OF MEANING and the process of acquiring meanings have been described we shall want to consider the psychological mechanisms whereby large quantities of subject matter knowledge are retained in cognitive structure over extended periods of time How is such knowledge assimilated and organized in cognitive structure and why is it subsequently forgotten? Is there more than one valid explanation for the discrepancy between learned and remembered content that is are there different kinds of forgetting? And lastly how does meaningful learning as a process differ from rote learning and why does it yield superior learning and retention? Before turning to these latter problems however it will be useful to reexamine some of the more salient properties of meaningful reception learning inasmuch as this type of learning underlies the acquisition of most subject matter knowledge

## The Nature of Meaningful Reception Learning

We have already indicated that the acquisition of subject matter knowledge is primarily a manifestation of reception learning That is the principal content of what is to be learned is typically presented to the learner in more or less final form Under these circumstances the learner is simply required to comprehend the material and to incorporate it into his cognitive structure so that it is available for either reproduction related learning or problem solving at some future date

Yet few pedagogic devices in our time have been repudiated more unequivocally by educational theorists than the method of expository verbal instruction It is fashionable in many quarters to characterize verbal learn ing as parrot like recitation and rote memorization of isolated facts and to dismiss it disdainfully as an archaic remnant of discredited educational tradition In fact quite apart from whatever intrinsic value they may possess many educational innovations and movements of the past three decades—activity programs project and discussion methods various ways of maximizing nonverbal and manipulative experience in the classroom emphasis on self discovery and on learning for and by *problem solving*—owe their origins and popularity to widespread dissatisfaction with the techniques of verbal instruction It is commonly accepted today for example (at least in the realm of educational theory) that (a) meaningful generalizations cannot be presented or given to the learner but can be acquired only as a product of problem solving activity (Brownell and Hendrickson 1950) and (b) all attempts to master verbal concepts and propositions are forms of empty verbalism unless the learner has recent prior experience with the realities to which these verbal constructs refer (Brownell and Hendrickson 1950 Brownell and Sims 1946)

Adequate reasons of course exist for some of the disenchantment with expository teaching and reception learning The most obvious of these is that notwithstanding repeated policy declarations of educational organizations to the contrary potentially meaningful subject matter is frequently presented to pupils in such a way that they can only learn it rotely Another less obvious but equally important reason why meaning is perceived as an exclusive product of problem-solving and discovery techniques of learning stems from two serious shortcomings of prevailing learning theory First psychologists have tended to subsume many qualitatively different kinds of learning processes under a single explanatory model As a result widespread confusion exists regarding basic distinctions between reception and discovery learning and between rote and meaningful learning It has not always been sufficiently clear for example that such categorically different types of learning as problem solving and the understanding of presented verbal material have different objectives and that conditions and instructional techniques facilitating one of these learning processes are not necessarily relevant or maximally efficient for the other Second in the absence of an appropriate theory of meaningful verbal learning many educational psychologists have tended to interpret long term subject matter learning and forgetting in terms of the same concepts (stimulus generalization retroactive interference) used to explain laboratory forms of rote learning It is hardly surprising therefore that reception learning has been widely perceived as without prior discovery experience or problem solving activity and that the invariable rote outcomes attributed to the method of expository verbal instruction do not inhere in the method itself but are derived from various misapplications

### *Is Reception Learning Meaningful?*

How valid is the contention that abstract concepts and generalizations are forms of empty meaningless verbalism unless the learner discovers them autonomously from his own concrete empirical problem solving experience? Careful analysis of this proposition reveals that it rests on three logical fallacies (a) the prevailing tendency to confuse the reception discovery dimension of the learning process with the rote meaningful dimension (b) a straw man representation of the method of reception learning and (c) unwarranted generalization of the distinctive developmental conditions of learning and thinking during childhood to adolescence and adult life The first of these fallacies has already been considered in some detail in Chapter 2

The use of the straw man technique was of course the simplest and most effective way of discrediting the method of verbal exposition Instead of describing this pedagogic procedure in terms of its essential characteristics it became fashionable to picture it in terms of its worst abuses Examples of such abuses were naturally not difficult to find since an appreciable number of teachers still rely on rote verbal learning in teaching potentially meaningful subject matter Some of the more flagrantly inept practices include premature use of pure verbal techniques with cognitively immature pupils arbitrary presentation of unrelated facts without any organizing or explanatory principles failure to integrate new learning tasks with previously presented materials and the use of evaluation procedures that merely measure ability to recognize discrete facts or to reproduce ideas in the same words or in the identical context as originally encountered

Although it is entirely proper to caution teachers against these frequent misuses of expository teaching it is not legitimate to represent them as inherent in the method itself An approach to instruction which on logical and psychological grounds appears appropriate and efficient should not be discarded as unworkable simply because like all pedagogic techniques in the hands of incompetent or unintelligent teachers it is subject to misuse It would seem more reasonable to guard against the more common misapplications and to relate the expository method to relevant theoretical principles and research findings that actually deal with the long term learning and retention of large bodies of potentially meaningful verbally presented materials

Some representatives of the progressive education movement speak with disdain about the school s role of imparting knowledge contrasting it with the allegedly more desirable role of helping children learn by themselves They assert that the former role is a paltry one and that it invariably re sults in the learning of glib and meaningless verbalisms This of course is not necessarily true provided that the obvious abuses of expository instruc tion are avoided Verbal exposition is actually the most efficient way of teaching subject matter and leads to sounder and less trivial knowledge than when pupils serve as their own pedagogues Thus the art and science of presenting ideas and information effectively—so that clear stable and unambiguous meanings emerge and are retained over a long period of time as an organized body of knowledge—is really one of the principal functions of pedagogy This is a demanding and creative rather than a routine or mechanical task The job of selecting organizing presenting and trans lating subject matter content in a developmentally appropriate manner re quires more than a rote listing of facts If it is done properly it is the work of a master teacher and is hardly a task to be disdained

Finally it is important to appreciate that various developmental con siderations limiting the meaningfulness of reception learning during child hood do not apply during adolescence and adult life It is true of course that learners who have not yet developed beyond the concrete operational stage of cognitive development are unable meaningfully to incorporate within their cognitive structures a relationship between two or more sec ondary abstractions unless they have the benefit of some current or recent concrete-empirical props (Inhelder and Piaget 1958) Thus during the con crete operational stage roughly covering the elementary school period chil dren are restricted by this degree of dependence on concrete-empirical ex perience to a semi abstract intuitive understanding of abstract propositions Such learners cannot comprehend or meaningfully manipulate in problem solving verbally or symbolically expressed abstract propositions without the aid of concrete-empirical props and even then their understanding tends to be intuitive and somewhat particularistic rather than precise explicit and truly abstract Reception learning at this stage is also limited by the lack of higher-order abstract concepts in cognitive structure to which large amounts of information may be related and by the lack of transactional terms for relating ideas to each other

These limitations obviously curtail rather drastically the scope of ex pository teaching and reception learning Nevertheless even during the elementary school years autonomous discovery is not indispensable for in tuitive understanding and need not constitute a routine part of pedagogic technique As every elementary school teacher knows meaningful verbal reception learning—without any problem solving or discovery experience whatsoever—is perhaps the commonest form of classroom learning provided that the necessary concrete-empirical props are available

During the abstract stage of cognitive development however beginning in the junior high school period students can acquire most *new concepts* and learn most new propositions by *directly* grasping higher-order relationships between abstractions (Inhelder and Piaget 1958) To do so meaningfully they *need no longer depend on current or recent concrete empirical* props and hence are able to bypass completely the intuitive type of understanding reflective of such dependence In large measure this development *reflects the availability of an adequate body of higher-order abstractions and* transactional terms Expository instruction thus becomes much more feasible Through reception learning students can proceed directly to a level of *abstract* understanding that is qualitatively superior to the intuitive level in terms of generality clarity precision and explicitness At this stage of development therefore properly arranged verbal reception learning is highly meaningful and hence it is unnecessary routinely to introduce concrete empirical props or time consuming discovery techniques in order to make possible or to enhance *intuitive* understanding of abstract propositions

This is the point at which some of the more zealous proponents of progressive education took a disastrously false turn John Dewey had correctly recognized that understanding of abstract concepts and principles in childhood must be built on a foundation of direct concrete empirical experience and for this reason advocated the use of project and activity methods in the elementary school But he also appreciated that once a firmly grounded first story of abstract understandings was established it is possible to organize secondary and higher education along more abstract and verbal lines Unfortunately however although Dewey himself never elaborated or implemented this latter conception some of his disciples took precisely the opposite position They blindly generalized childhood limiting conditions with respect to meaningful abstract reception learning broadly enough to encompass learning over the entire life span And this unwarranted extrapolation frequently but erroneously attributed to Dewey himself provided an apparent rationale for and thus helped perpetuate the seemingly indestructible myth that under any and all circumstances abstractions cannot possibly be meaningful unless preceded by direct empirical experience

### *Is Meaningful Reception Learning Passive?*

The acquisition of meanings through meaningful *reception learning* is far from being a passive kind of cognitive process Much activity is obviously involved but not the kind of activity characterizing discovery Activity and *discovery are not synonymous in the realm of cognitive functioning* Merely because potential meanings are presented we cannot assume that they are necessarily *acquired* and that all subsequent loss is reflective of forgetting

Before meanings can be retained they must first be acquired and the process of acquisition is typically active Neither can we assume that reception learning is necessarily more passive and mechanical than independent data gathering and interpretation The unmotivated student who gathers and interprets data manifests no greater intellectual activity than the unmotivated student who receives expository instruction The motivated student on the other hand, reflectively considers reworks and integrates new material into his cognitive structure irrespective of how he obtains it

Thus meaningful reception learning involves more than the simple cataloguing of ready made concepts within existing cognitive structure In the first place at least an implicit judgment of relevance is usually required *in deciding which* established ideas in cognitive structure are most relatable to a new learning task. Second some degree of reconciliation between new ideas and similar established ideas is often necessary to differentiate between them particularly if there are discrepancies or conflicts Third new propositions are customarily reformulated to blend into a personal frame of reference consonant with the learner s experiential background vocabulary and structure of ideas Lastly if the learner in the course of meaningful reception learning cannot find an acceptable basis for reconciling apparently or genuinely contradictory ideas he is sometimes inspired to attempt a degree of synthesis or reorganization of his existing knowledge under more inclusive and broadly explanatory principles He may either seek such propositions in more recent or sophisticated expositions of a given topic or under certain circumstances may try to discover them himself

All of this activity (except for the last mentioned) however stops short of actual discovery or problem solving Since the substance of the learning task is essentially presented the activity involved is limited to that required for effectively assimilating new meanings and integrating them into existing cognitive structure This is naturally of a *qualitatively* different order than that involved in independently discovering solutions to new problems—in autonomously reorganizing new information and existing ideas in cognitive structure in such a way as to satisfy the requirements of a given problem situation

The extent to which meaningful reception learning is active depends in part on the learner s need for integrative meaning and on the vigorousness of his self-critical faculty He may either attempt to integrate a new proposition with *all* of his existing relevant knowledge or remain content with establishing its relatedness to a single idea Similarly he may endeavor to translate the new proposition into terminology consistent with his own vocabulary and ideational background or remain satisfied with incorporating it as presented. Finally he may strive for the acquisition of precise and unambiguous meanings or may be completely satisfied with vague diffuse notions

The main danger in meaningful reception learning is not so much that the learner will frankly adopt a rote approach but rather that he will delude himself into believing that he has *really* grasped precise intended meanings when he has grasped only a vague and confused set of empty verbalisms *It is not so much that he does not want to understand but that he lacks the* necessary self critical ability and is unwilling to put forth the necessary active effort in struggling with the material in looking at it from different angles in reconciling and integrating it with related or contradictory knowledge and in reformulating it from the standpoint of his own frame of reference He finds it easy enough to manipulate words glibly so as to create a spurious impression of knowledgeability and thereby to delude himself and others *into thinking that he truly understands when he really does not*

A central task of pedagogy therefore is to develop ways of facilitating an active variety of reception learning characterized by an independent and critical approach to the understanding of subject matter This involves in part the encouragement of motivations for and self critical attitudes toward acquiring precise and integrated meanings as well as the use of other techniques directed toward the same end Precise and integrated understandings are presumably more likely to develop if the central unifying ideas of a discipline are learned before more peripheral concepts and information are introduced *if the limiting conditions of general developmental readiness* are observed if precise and accurate definition is stressed and emphasis is *placed on delineating similarities and differences between related concepts* and if learners are required to reformulate new propositions in their own words All of these latter devices come under the heading of pedagogic techniques that promote an active type of meaningful reception learning Teachers can help foster the related objective of assimilating subject matter critically by encouraging students to recognize and challenge the assumptions underlying new propositions and to distinguish between facts and hypotheses and between warranted and unwarranted inferences Much good use can also be made of Socratic questioning in exposing pseudo understanding in transmitting precise meanings in reconciling contradictions and in encouraging a critical attitude toward knowledge

## *The Assimilation Process in the Acquisition* Retention and Organization of Knowledge

To account more completely for the acquisition retention and organization of meanings in cognitive structure it is necessary at *this point to* introduce the further principle of *assimilation* This can be done more clearly by making parallel reference to a diagrammatic representation of it (Table 3) that uses formal symbols and depicts successive stages in the ac quisition and retention of a subordinate meaning. This is the type of meaning that results when a potentially meaningful concept or proposition *a* can be subsumed under a *more inclusive* established idea *A* in cognitive structure as an example, extension, elaboration, modification, or qualification of the established idea. For example, when students in our culture are first introduced to the unfamiliar Buddhist concept of sin, they presumably tend to subsume it as a modified variant under its established Judeo-Christian counterpart in their cognitive structures. As suggested in Chapter 2, the new meaning *a'* that emerges when *a* is related to and interacts with *A* in this fashion is the product of this interaction between them and is itself a differentiated cognitive content.

Stating the case more precisely, however, the *actual* or total interactional product of the new idea and the established idea, as shown in Table 3, is hypothesized as being greater and more complex than is originally described. This is where the concept of assimilation enters the picture—an aspect of the meaningful learning process that was deliberately not introduced earlier to avoid overcomplicating the issue unnecessarily at that point. In the first place, not only the new potentially meaningful idea *a*, but the established idea *A* to which it is related is changed as well by the interactional process; this is indicated in Table 3 by the use of the prime sign in each case. Second and more important, both interactional products *a'* and *A' remain in relationship* to each other as linked co-members of a new composite ideational unit or ideational complex, *A'a'*. In the more complete sense of the term, therefore, the actual interactional product of the meaningful learning process is not just the new meaning *a'*, which is really only a partial product of the interaction, but the entire new ideational complex. The additional term "assimilation" is thus needed to refer to the further hypothesis that even *after* the new meaning emerges, it continues to remain in linked relationship to the slightly modified form of the established idea in cognitive structure—as the *less* stable co-member of the new ideational unit so formed—and hence to remain within the ideational orbit of the established idea. A later aspect of the assimilation process, to be discussed below, that provides further justification for the use of the term "assimilation," as it is commonly understood, is the hypothesized tendency for the new meaning to be "reduced" to the meaning of the more established idea.

### *The Explanatory Value of Assimilation*

The assimilation hypothesis has explanatory value at this point because it helps account both for the memorial longevity of *meaningfully* learned ideas and for the way in which knowledge is organized in cognitive structure. Assimilation could conceivably enhance retention in three differ

## TABLE 3

STAGES IN THE LEARNING AND RETENTION OF A *SUBORDINATE IDEA IN* RELATION TO ITS DISSOCIABILITY STRENGTH

| | | | | | | |
|---|---|---|---|---|---|---|
| I | MEANINGFUL LEARNING OR ACQUISITION OF SUBORDINATE MEANING $a'$ | New, Potentially Meaningful Idea $a$ | related to and assimilated by | Established Idea $A$ in Cognitive Structure | $\longrightarrow$ | Interactional Product $A'\ a'$ |
| II | POST LEARNING AND EARLY RETENTION OF MEANING $a'$ | New meaning $a'$ is dissociable from $A'\ a'$ | $A'\ a' \rightleftarrows A' + a'$ (high dissociability strength) | | | |
| III | LATER RETENTION OF MEANING $a'$ | Gradual loss of dissociability of $a'$ from $A'\ a'$ | $A'\ a' \rightleftarrows A' + a'$ (low dissociability strength) | | | |
| IV | FORGETTING OF MEANING $a'$ | $a$ is no longer effectively dissociable from $A\ a'$ | | Dissociability of $a'$ from $A'\ a'$ is below the threshold of availability $a'$ is reduced to $A'$ | | |

ent ways. First, by becoming "anchored," so to speak, to a modified form of a highly stable existing idea in cognitive structure, the new meaning vicariously shares the stability of the latter.[1] Second, this type of anchorage, by *continuing* during storage the *original* nonarbitrary relationship between the new idea and the established idea, also protects the new meaning from the interference exerted by previously learned, concurrently experienced, and subsequently encountered similar ideas. This interference is what is so damaging when learning material is arbitrarily related to cognitive structure. Lastly, the fact that the new meaningful idea is stored in linked relationship to the *particular* idea(s) in cognitive structure to which it is most relevant (that is, to the idea(s) to which it was originally related in acquiring its meaning) presumably makes retrieval a less arbitrary and more systematic process.

The assimilation hypothesis can also help explain how knowledge is organized in cognitive structure. If new ideas are *stored* in linked relationship to correspondingly relevant existing ideas in cognitive structure, and if it is also true both that one member of the linked pair is typically superordinate to or more inclusive than the other and that the superordinate member (at least, once it is established) is the more stable member of the pair, then it necessarily follows that the cumulative residue of what is learned, retained, and forgotten (the psychological structure of knowledge or cognitive structure as a whole) conforms to the organizational principle of progressive differentiation. Thus, if the principle of assimilation were actually operative in the storage of meaningful ideas, it would then be quite understandable why an individual's organization of the content of a particular subject-matter discipline in his own mind exemplifies a hierarchically ordered pyramid in which the most inclusive and broadly explanatory ideas occupy a position at the apex of the pyramid and subsume

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[1] It will be convenient henceforth to refer to the established relevant idea $A$ in cognitive structure to which the new potentially meaningful idea $a$ is related as the "anchoring idea." Strictly speaking, however, the actual anchoring idea is $A'$—not $A$, but this distinction can be ignored for all practical purposes since $A'$ and $A$ are not very different from each other. It *is* important to bear in mind that it is not $a$ that is anchored to $A$, but rather $a'$ (the meaning of $a$).

It should also be noted that the term "assimilation" has been used here in the narrow sense of the term to apply to the linkage of the emergent new meaning with the anchoring idea for storage and to the later reduction process. It would also be legitimate to include the earlier aspects of the meaningful learning process (in which the new idea is related to and interacts with the established idea) as part of assimilation in the broader sense of the term. This broader usage is not only consistent with what is usually meant by assimilation but is also consistent with the fact that the linkage of the new meaning with the anchoring idea necessarily implies that the potentially meaningful idea is *first* related to and interacts with the established idea.

progressively less inclusive, or more highly differentiated, ideas, each linked to the next higher step in the hierarchy through assimilative bonds

As suggested above, the assimilation or anchoring process probably has a generally facilitating effect on retention However, to explain how newly assimilated meanings actually become available during the retention period, it is necessary to assume that for a variable period of time they are *dissociable* from their anchoring ideas, and hence are reproducible as individually identifiable entities Thus, as shown in Table 3, the newly learned and assimilated meaning *a'* is initially dissociable from its linked relationship to anchoring idea *A'*, the interactional product *A'a'*, in other words, dissociates into *A'* and *a'* Universal experience indicates that degree of dissociability or dissociability strength is at a maximum immediately after learning, and therefore that new meanings, in the absence of direct or indirect practice, are maximally available at that time

### *Memorial Reduction*

The attractiveness of the assimilation process inheres not only in its ability to account for the superior retention of meaningfully learned ideas, but also in the fact that it implies a plausible mechanism for the subsequent forgetting of these ideas, namely, the gradual reduction of their meanings to the meanings of the corresponding anchoring ideas to which they are linked Thus, although the retention of newly learned meanings is enhanced by anchorage to relevant established ideas in the learner s cognitive structure, such knowledge is still subject to the erosive influence of the general reductionist trend in cognitive organization Because it is more economical and less burdensome merely to retain the more stable and established anchoring concepts and propositions than to remember the new ideas that are assimilated in relation to them, the meaning of the new ideas tends to be assimilated or reduced, over the course of time to the more stable meanings of the established anchoring ideas Immediately after learning, therefore, when this second or *obliterative* stage of assimilation begins, the new ideas become spontaneously and progressively less dissociable from their anchoring ideas as entities in their own right, until they are no longer available and are said to be forgotten When the dissociability strength of *a'* falls below a certain critical level (the threshold of availability), it is no longer effectively dissociable from *A'a'* (in other words is no longer retrievable) Eventually zero dissociability is reached, and *A'a'* is further reduced to *A'* itself, the original anchoring idea

The concept of a variable threshold of availability is useful because it can explain transitory fluctuations in availability that are attributable to general cognitive or motivational variables (attention, anxiety, change of set or context, release of repression) without any change in dissociability strength (the intrinsic strength of the item in memory) itself By the same token it explains why items of low dissociability strength, that are ordinarily not available under typical conditions of consciousness, are available under hypnosis, and why such items can be recognized but not recalled

Forgetting is thus a continuation or later temporal phase of the same assimilative process underlying the availability of newly learned ideas And the same nonarbitrary relatability to a relevant established idea in cognitive structure that is necessary for the meaningful learning of a new idea and that leads to its enhanced retention through the process of anchoring the emergent meaning to that of the established idea, provides the mechanism for most later forgetting

This process of memorial reduction to the least common denominator capable of representing cumulative prior ideational experience (to the relevant established ideas) is very similar to the reduction process characterizing concept formation A single abstract concept is more manipulable for cognitive purposes than the dozen diverse instances from which its commonality is abstracted, and, similarly, stable and established ideas in cognitive structure are also more functional for future learning and problem solving operations when stripped of the less stable meanings they have assimilated Hence, barring repetition or some other special reason (for example, primacy, uniqueness enhanced discriminability, or the availability of a specially relevant clear, and stable anchoring idea) for the perpetuation of their dissociability, newly learned ideas that are related to established ideational systems tend gradually and spontaneously to become undissociable from their anchoring ideas—to undergo obliterative assimilation, or to be forgotten Forgetting thus represents a progressive loss in the dissociability of newly assimilated ideas from the ideational matrix in which they are imbedded and in relation to which their meaning emerges

Unfortunately however the advantages of obliterative assimilation for cognitive functioning are gained at the expense of losing the differentiated body of detailed propositions and specific information that constitute the flesh, if not the skeleton of any body of knowledge The main problem of acquiring the content of an academic discipline therefore, is counteracting the inevitable process of obliterative assimilation that characterizes all meaningful learning

In the case of subordinate and combinatorial learning the process of obliterative assimilation, as a reduction phenomenon, seems straightforward enough the less stable (and more specific) meaning of a subordinate idea, is gradually incorporated within or reduced to the more stable (and more inclusive) meaning of the specifically relevant idea in cognitive structure that assimilates it, and the less stable (and more specific) meaning of a combinatorial idea is similarly incorporated within or reduced to the more stable (and more generalized) meanings of the wider, less specifically relevant body of ideas in cognitive structure to which it is related But what about the forgetting of *superordinate* learnings which, by definition, are more generalized and inclusive from the very beginning than the established subordinate ideas in cognitive structure that assimilate them? Here the process of obliterative assimilation must obviously conform to a somewhat different paradigm, since the more stable anchoring ideas in this case are *less* inclusive than the new superordinate meanings they assimilate At least in the beginning, therefore, while a new superordinate meaning is relatively unstable, it is reduced to its less inclusive (subordinate) anchoring ideas during the process of obliterative assimilation Later, however, if and when the new superordinate idea is overlearned, it tends to become more stable than the subordinate ideas that originally assimilated it, inasmuch as the stability of an idea in memory, everything else being equal, tends to increase with its level of generality and inclusiveness Thus, at this point, the direction of obliterative assimilation is reversed the less inclusive, and now less stable, meanings of earlier learned subordinate ideas tend to be incorporated within or reduced to the more generalized meaning of the later-learned and now more stable meanings of the superordinate idea (see Table 4)

The dynamics underlying the meaningful learning, retention, and forgetting of ideas can be appreciated more fully by considering certain detailed aspects of the interactional and assimilation processes that have not been mentioned as yet Referring again to Table 3 consider, for example, the natural history of a potentially meaningful correlative concept or proposition $a$ which a learner relates to (subsumes under) a specifically relevant and more inclusive and stable established proposition $A$ in his cognitive structure As a result of the subsumption process, an interactional product, $A'a'$, is formed in which both original components are modified as a consequence of the interaction It is obviously an over simplification, however, to state that a new learning item, $a$, forms only a single interactional product with $A$ To a lesser extent it forms additional interactional products with other ideas which could be called $B$, $C$, $D$, $E$, and so forth, the amount of assimilation in each case being roughly proportional to the latter s place along a gradient of relevance In this interaction, also the subsuming idea is ordinarily modified much less than is the subsumed item because of its greater inclusiveness and stability A recently learned abstract concept, however, may be modified considerably by particular new experience Its defining attributes, for example, may be broadened to include new features that were formerly excluded, or may be made less inclusive by excluding features that were originally included

Now, in this new interactional product, $A'a'$, $a'$ does not lose its identity completely, since a dissociation equilibrium, $A'a' \rightleftarrows A' + a'$, is set up in which $a'$, depending on prevailing conditions, has a given degree of dis-

TABLE 4

STAGES IN THE LEARNING AND RETENTION OF A SUPERORDINATE IDEA IN RELATION TO DISSOCIABILITY

| | | | | | | |
|---|---|---|---|---|---|---|
| I | MEANINGFUL LEARNING OR ACQUISITION OF SUPERORDINATE MEANING $A$ | New Potentially Meaningful Idea $A$ | related to and assimilated by | Established Ideas $a$ and $\alpha$ | $\longrightarrow$ | Interactional Product $a'\ \alpha'\ A$ |
| II | POST LEARNING AND EARLY RETENTION OF $A$ | New meaning $A$ is dissociable from $a'\ \alpha'\ A'$ | $a'\ \alpha'\ A' \rightleftarrows a' + \alpha' + A'$ | | | |
| III | FORGETTING OF $A$ | $A$ is no longer effectively dissociable from $a'\ \alpha'\ A'$ | $A'$ is reduced to $a' + \alpha'$ | | | |
| IV | OVERLEARNING OF $A'$ | $a'$ and $\alpha'$ | subsumed under | More Stable and Established Idea $A'$ | $\longrightarrow$ | Interactional Product $A'\ a'\ \alpha'$ |
| V | LATER RETENTION OF $a'$ and $\alpha'$ | $a'$ and $\alpha'$ are dissociable from $A'\ a'\ \alpha'$ | $A'\ a'\ \alpha' \rightleftarrows A' + a' + \alpha'$ | | | |
| VI | FORGETTING OF $a'$ and $\alpha'$ | $a'$ and $\alpha'$ are no longer effectively dissociable from $A\ a\ \alpha'$ | $a$ and $\alpha'$ are reduced to $A'$ | | | |

sociability as an identifiable entity As will be explained in greater detail later (Chapter 4), the original degree of dissociability strength of *a'*, after meaningful learning occurs, varies with such factors as the relevance of the anchoring idea *A*, the stability and clarity of *A*, and the extent to which *A* is discriminable from the learning material (that is, from *a*)

Actually, of course, assimilated items become unavailable (forgotten) long before the point of zero dissociability is reached, since they are no longer available below the prevailing *threshold of availability* (the critical level of strength a given item must manifest in order to be retrievable) *Much residual dissociability strength exists between this below* threshold level and the point of zero dissociability, but not enough to make the item available under ordinary conditions of recognition or recall The existence of below threshold dissociability may be demonstrated by the use of hypnosis (Nagge, 1935, Rosenthal, 1944) which greatly lowers the threshold of availability *for all items, with the result that many items which are below the* level of availability become available under hypnosis Relearning also demonstrates subthreshold dissociability strength (Burtt, 1941) The fact that forgotten materials can be *relearned* more effectively and in less time than that required for original learning is ample proof of the existence of subthreshold dissociability strength, because its presence, less new learning is required to reach any given threshold level

*This concept of a dissociation equilibrium, in which an assimilated* idea gradually and spontaneously becomes less dissociable from the established ideational system to which it is anchored and from which it derives its meaning has considerable heuristic value It accounts *both* for the original availability of the newly learned meaning *and* for the subsequent *gradual* decline in its availability during the retention interval until forgetting ensues As will be pointed out shortly, assimilation theory differs *markedly in principle from the Gestalt theory of forgetting in this respect* Gestalt theory holds that the assimilative process induced by interaction between traces is a matter of all or none replacement of a given trace by another stronger trace, on the basis of the similarity existing between them

The familiar Gestalt phenomena of leveling and of sharpening in which forgetting is manifested by reduction to a familiar idea by accentuation of a salient characteristic can be easily reinterpreted in terms of assimilation *theory In the process of leveling* (Allport and Postman, 1947, Wulf, 1922) for example, *a*, which is a specific derivative or illustration of *A* or a slightly asymmetrical or incomplete variant of *A*, *becomes a' after it is* learned and is simply reduced to *A'* in the course of forgetting, whereas in the process of sharpening, a more striking aspect of *a* becomes its criterial feature and is remembered in accentuated form because it is subsumed under and eventually reduced to a pre existing representation of this feature in cognitive structure Continuous and inverse principles, and principles with greater in discovery than in reception learning. In discovery learning, repeated encounters with the learning task give rise to successive stages in an autonomous problem solving process, whereas in reception learning, repetition (apart from some possible changes in degree and precision of meaning) primarily increases the future availability of the material. Thus the forgetting aspect of discovery learning hardly constitutes just a later continued phase of an original learning process that merely requires the learner to internalize and make presented material more available. Forgetting in this instance, therefore, has little in common with most of discovery learning in which meaning must first be discovered by problem solving before it can be made available and retained.

### *Derivative versus Correlative Subsumption*

It is necessary to distinguish between two basically different kinds of subsumption that occur in the course of meaningful learning and retention. *Derivative* subsumption takes place when learning material is understood as a specific example of an established concept in cognitive structure or is supportive or illustrative of a previously learned general proposition. In either case the new material to be learned is directly and self-evidently derivable from or implicit in an already established and more inclusive concept or proposition in cognitive structure. Under these circumstances, the meaning of the derivative material emerges quickly and *relatively* effortlessly, and unless greatly overlearned tends to undergo obliterative subsumption relatively rapidly. The reason for the rapid obliterative subsumption is simply that the meaning of the new material can be very adequately represented by the more general and inclusive meaning of the established subsumer and that this latter process of memorial representation is more efficient and less burdensome than the actual retention of supportive or illustrative data. If such data are needed, they can be synthesized or reconstructed by appropriately manipulating specific elements of past and present experience so that they exemplify the desired concept or proposition. For example, in recounting a long past incident one ordinarily retains only the ideational substance of the experience and from this reconstructs or invents plausible details that are consistent with its general import and setting.

More typically, however new subject matter is learned by a process of *correlative* subsumption. The new learning material in this case is an extension elaboration modification, or qualification of previously learned propositions. It is incorporated by and interacts with relevant and more inclusive subsumers in cognitive structure, but its meaning is not implicit in, and cannot be adequately represented by, these latter subsumers. Nevertheless in the interests of economy of cognitive organization and of reducing the burden on memory the same trend toward obliterative subsumption occurs. This trend is particularly evident if the subsumers are unstable, un clear, or insufficiently relevant, or if the learning material is lacking in discriminability or is not overlearned. But in this instance, the consequences of obliterative subsumption are not as innocuous as in the case of derivative subsumption. When correlative propositions lose their identifiability and can no longer be dissociated from their subsumers, a genuine loss of knowledge occurs. The subsumers cannot adequately represent the meaning of the new correlative propositions, and hence the mere availability of the subsumers in memory does not make possible a reconstruction of the substance of the forgotten material. The same situation exists when new superordinate and combinatorial meanings are forgotten.

The acquisition of a body of knowledge, therefore, is largely a matter of counteracting the trend toward obliterative assimilation in retaining correlative, superordinate, and combinatorial learnings. Thus J. S. Bruner's exclusive emphasis on "generic learning" or on acquiring "generic coding systems," as a means of facilitating school learning (1957, 1959, 1960) is unrealistic because it focuses on derivative aspects of subsumption which are atypical both of the assimilation process in general and of most instances of assimilating new subject matter. It is true, as he asserts, that most specific content aspects of subject matter can be forgotten with impunity as long as they are derivable, or can be reconstructed when needed, from those generic concepts or formulae which are remembered. But the analogous forgetting of correlative, superordinate, or combinatorial content results in a loss of knowledge that cannot be regenerated from residual generic concepts. The reductionist trend in memory (that is, obliterative assimilation), which is functional or, at the very worst, innocuous in the case of derivative material, constitutes the principal difficulty in acquiring a body of knowledge in the more typical context of learning correlative, superordinate, or combinatorial propositions.

Hence, the problem of meaningful learning and retention cannot ordinarily be solved by incorporating "a representation of the criterial characteristics of [a] situation [or] a contentless depiction of the ideal case" (Bruner, 1960) and then ignoring the loss of specific content that occurs. The main purpose of learning generic concepts and propositions is *not* so much to make possible the reconstruction of forgotten derivative instances as to provide stable anchorage for the learning of correlative, superordinate, or combinatorial material, and it is the inhibition of the rate of obliterative assimilation in relation to this material that is the major problem confronting teachers in transmitting subject matter.

### *Assimilation of Abstract versus Factual Materials*

The extent to which learning material is either abstract or factual in nature has an important bearing on its longevity or on the rate at which obliterative assimilation takes place Comparison of the relative retention spans of substance and verbatim items invariably shows that the longevity of different components of the learning material, all other factors being equal, varies directly with degree of abstractness The principal distinction between abstract and factual items, of course, is in terms of level of particularity or proximity to concrete-empirical experience Typically, however, abstract material is also characterized by greater connectedness or less discreteness than is factual material

All factual material, furthermore, is not of one piece Some factual material can be learned meaningfully, whereas other factual data cannot be related to cognitive structure in nonarbitrary, nonverbatim fashion, and hence must be rotely learned But even if factual matter is potentially meaningful, it is more likely to be rotely learned than is abstract material because it is more difficult to relate to existing ideational systems in cognitive structure

The previously made distinction between derivative and correlative subsumption is also important in accounting for the relative susceptibility to obliterative subsumption of different kinds of potentially meaningful factual material Derivative facts undergo obliterative subsumption more rapidly because, unlike correlative matter their meaning can be adequately represented by the ideational systems that subsume them thereby making possible a degree of factual reconstruction that is satisfactory enough for most purposes of communication

The greater longevity of abstract than of factual material, therefore, can undoubtedly be partly accounted for in terms of the superiority of meaningful over rote learning and retention Another credible explanation is that abstractions tend more often than factual material to be correlative rather than derivative in nature Hence, because they are from the very beginning much less close than factual matter to the end point of obliterative subsumption they can be retained for longer periods of time

### *Assimilation Inductive or Deductive Process?*

At first glance, one might suppose that assimilation in accordance with the principle of progressive differentiation conforms to a deductive approach to cognitive organization and functioning Actually, however, this supposition is correct only with respect to the relatively rare instance of derivative subsumption Correlative, combinatorial, and superordinate materials quite obviously do not bear a deductive relationship to their established anchoring ideas in cognitive structure Hence, simply because assimilation is not an inductive process we cannot consider it to be necessarily deductive in nature The inductive deductive issue is mostly relevant in considering the order in which generalizations and supportive data are handled, either in presenting knowledge or in problem solving—not in characterizing the nature of the assimilation process

Irrespective of whether new propositions are acquired inductively or deductively, however, their incorporation into cognitive structure still follows, if at all possible, the principle of progressive differentiation At all age levels and at all levels of cognitive sophistication, new subordinate propositions—even when acquired inductively—are invariably subsumed under more inclusive established ideational systems in cognitive structure, that is, they are hierarchically organized in cognitive structure New super ordinate propositions, in turn subsume less inclusive existing ideational systems [2] Moreover, it is questionable whether a pure inductive approach ever exists as such in problem solving Human beings rarely start out from scratch in approaching new problems They either employ explicit explanatory principles (hypotheses) on a provisional basis and try to fit the data to these hypotheses, or at the very least are implicitly guided from the outset by a set of general assumptions derived from past experience In this sense, therefore, inductive problem solving itself may be considered a subsidiary phase within a generally deductive approach

### *Cognitive Organization in Children*

Does the same hierarchical organization of knowledge based on the principle of progressive differentiation hold true for elementary school children, as well as for adolescents and adults, despite the fact that such children are dependent on concrete empirical experience in learning unfamiliar new abstractions and relationships between abstractions? It would appear that an affirmative answer to this question is warranted Even though the initial emergence of abstract meanings must be preceded by an adequate background of concrete empirical experience, abstract concepts and propositions, once satisfactorily established enjoy a very stable existence They not only do not have to be reinforced by reference to concrete, particular experience in order to maintain their meaning but they also serve as subsumers in the assimilative process, at or near the apex in the hierarchical organization of cognitive structure

Thus, the cognitive organization of children differs mainly from that of adults in containing fewer abstract concepts fewer higher-order abstractions, and more intuitive nonverbal rather than abstract verbal understandings of

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[2] New combinatorial propositions at the moment of incorporation are neither subordinate or superordinate to particular established ideas in cognitive structure almost inevitably however they either subsume or are subsumed by later learnings Originally they are coordinate in level of abstraction and inclusiveness with existing higher order concepts or propositions

many propositions Children s learning of new verbal material can therefore proceed in much the same manner as in adults—as long as proper allowance is made for the smaller number of higher-order abstract concepts and truly abstract propositions in cognitive structure and for the need for concrete empirical experience in acquiring abstract concepts and propositions

## The Threshold of Availability

### Reminiscence

We have already observed that in order for assimilated materials to be reproducible at some future date their dissociability strength must exceed a certain minimal value namely the threshold of availability The most important cause of the unavailability of meaningfully learned materials therefore is a fall in dissociability strength below the level required to reach this threshold Whether or not dissociability strength is sufficient to exceed threshold value however is partly a function of the method used in measuring retention Recognition and recall for example make quite different demands on the availability of a given item In the case of recognition the originally learned material is presented with other alternatives and the subject need only identify it in the case of recall the subject must *spontaneously* reproduce the substance of the original material Obviously therefore recognition can be successful at a much lower level of dissociability strength than can recall Items on the tip of one s tongue that cannot be recalled spontaneously can be both recalled with the aid of a hint (providing the first letter of the correct answer) and recognized correctly on a multiple choice test (Freedman and Landauer 1966) Subjects can even predict recognition successes and failures for items they cannot recall (J J Hart 1965) The threshold of availability in other words is higher for recall than for recognition if dissociability strength is held constant

Still another independent although secondary source of variability in the availability of subsumed materials inheres in fluctuations in the *threshold of availability itself* Hence a particular item of knowledge may manifest more than sufficient dissociability strength to exceed the *typically* prevailing threshold value but may still be unavailable because of some temporary elevation of the threshold of availability The most common reasons for such an elevation of threshold value are (a) initial learning shock (see below) (b) the competition of alternative memories and (c) negative attitudinal bias or motivation *not* to remember (repression) Removal of these threshold raising or memory inhibiting factors (that is disinhibition) results in an apparent facilitation of memory The most extreme example of disinhibition occurs during hypnosis when restriction of the learner s field of awareness reduces the competing effect of alternative memory systems to a bare minimum (Rosenthal, 1944)

Reminiscence (the Ballard Williams phenomenon) refers to an apparent increment in the retention of meaningfully learned material over a period of two or more days without any intervening practice[3] Since retention cannot possibly exceed original learning under these conditions, this phe nomenon is probably reflective of spontaneous recovery from the threshold elevating effects of initial learning shock It is postulated, in other words, that a certain amount of resistance and generalized cognitive confusion occur when unfamiliar new ideas are first introduced into cognitive struc ture, that this confusion and resistance are gradually dissipated as the new ideas become more familiar and less threatening, and that the existence of the initial resistance and confusion and their gradual dissipation are paral lelled, respectively, by a corresponding initial elevation and a subsequent lowering of the threshold of availability This interpretation is strengthened by the fact that reminiscence occurs only when material is partially learned or not overlearned, and when practice trials are massed, that is when opportunity for immediate confusion and later clarification exists

The fact that reminiscence has been convincingly demonstrated only in elementary school children (Sharpe, 1952, Stevenson and Langford, 1957, O Williams, 1926) and declines (Sharpe, 1952) or is not manifested at all (O Williams, 1926) in older subjects, suggests that initial 'learning shock tends to decrease with increasing age as cognitive structure becomes more stable and better organized Reminiscence also cannot be demonstrated for verbatim (Edwards and English 1939, English, Welborn, and Kilian, 1934) and rotely learned (L B Ward 1937) materials unless measured within minutes after learning, inasmuch as the retention span for such materials is exceedingly brief Later increments in retention (increments other than a gain between an *immediate* and a subsequent test of memory) are, by defini tion not indicative of reminiscence, they probably reflect the later removal of competing memories (or of negative motivational factors) temporarily raising the threshold of availability during the preceding retention test, rather than the dissipation of initial learning shock

The genuineness of reminiscence was originally in doubt because early studies (Ballard 1913, Edwards and English 1939, English, Welborn and Kilian 1934) used the *same* group of subjects in making both initial and subsequent tests of retention It was possible, therefore to explain reminis cence either in terms of the practice effect exerted by the immediate test of

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[3] Short term reminiscence manifested 2 to 6 minutes after learning (the Ward Hovland phenomenon) will not be considered here since it is concerned with rote memorization

recall, or in terms of voluntary or involuntary rehearsal between immediate and later tests of retention Since the reminiscence effect still shows up, however, when *separate* groups are used in determining immediate and later tests of availability (Sharpe, 1952, Stevenson and Langford, 1957) it is in all probability more than a mere artifact of method of measurement

## Sources of Forgetting

Temporally, three distinct phases may be distinguished during meaningful reception learning and retention Each phase, in turn, contributes in distinctive ways to measured discrepancies between presented learning material and reproduced memories of this material During the first phase, *learning*, meanings are acquired Potentially meaningful ideas and information are related to relevant ideational systems in cognitive structure, thereby giving rise to idiosyncratic phenomenological meanings with a given degree of dissociability strength The second phase is concerned with the *retention* of acquired meanings or with the gradual loss of dissociability strength through a process of obliterative assimilation

The third and final phase involves the *reproduction* of the retained material It depends not only on the residual degree of availability (dissociability strength) in relation to the threshold of availability, but also on cognitive and motivational factors influencing both this threshold and the actual process of reconstructing or reformulating the retained meanings into a verbal statement

It is important to bear in mind these various temporal phases of meaningful reception learning and retention in accounting for the various sources of error in memory During the *learning* phase vague, diffuse, ambiguous, or erroneous meanings may emerge from the very beginning of the learning process because of the unavailability of relevant anchoring ideas in cognitive structure, because of the instability or unclarity of these anchoring ideas, or because of the lack of discriminability between the learning material and the anchoring ideas This unfavorable outcome is particularly likely if the learner s need for and self-critical attitude about, acquiring adequate meanings is deficient

Another source of discrepancy between presented and remembered content that is attributable to this first phase reflects the selective emphasis omission, and distortion that takes place as a result of initial interpretation of the presented material As will be pointed out shortly in the discussion of F C Bartlett s theory of forgetting these phenomena are manifestations of the *selective* emergence of meaning (a *cognitive* process) rather than of selective perception The emerging new meanings of learners are consonant with their cultural frames of reference (Bartlett, 1932), attitudinal biases

(McKillop, 1952), and experimentally manipulated advance sets (Jones and de Charms, 1958), because each individual possesses an *idiosyncratic* array of established and relevant anchoring ideas (including biases) in his cognitive structure which assimilate the new material, and the resulting meanings in each case are a function both of the *particular* assimilations that occur and of the selective distortion, discounting, dismissal, and reversal of intended meanings that are induced by his particular set of biases[4] In all of these instances, the relative weight of idiosyncratic cognitive structure in determining the content of meanings was greater than that of the learning material itself, because the investigators used prose material that was unfamiliar, ambiguous, cryptic, and interpretable in several alternative ways

Contrary to common belief, the fast learner remembers more than the slow learner This is so not because he forgets at a slower rate but because he learns more in a given unit of time and thus starts out with a greater mass of knowledge If initial level of mastery is held constant, there is no difference in retention between fast and slow learners (Underwood, 1954)

During the second phase the *retention period itself*, newly learned meanings tend to be reduced to the established ideas in cognitive structure that assimilate them That is, they tend to become more unqualified and similar in import to the anchoring ideas The *same* cognitive structure, practice, and task variables that influence the *original* dissociability strength and veridicality of the emerging meanings determine their *subsequent* dissociability strength and resistance to obliterative assimilation during the retention interval

Lastly, during the *reproductive* phase, factors raising the threshold of availability may inhibit the recall of ordinarily available meanings or available meanings may be altered in the very process of being reconstructed in accordance with the requirements of the current reproductive situation This phase is more important in cultural settings where students are expected and trained to demonstrate retention by reconstructing their knowledge, as in essay tests rather than by recognizing the correct alternative among multiple choices (Harari and McDavid 1966)

## Meaningful versus Rote Learning

Meaningfully and rotely learned materials are learned and retained in qualitatively different ways because potentially meaningful learning tasks are, by definition relatable and anchorable to relevant established ideas in

[4] For a more complete account of how attitudinal bias influences the learning of controversial material see Chapter 10

cognitive structure. They can be related to existing ideas in ways making possible the understanding of various kinds of significant (derivative, correlative, superordinate, combinatorial) relationships. Most new ideational materials that pupils encounter in a school setting are nonarbitrarily and substantively relatable to a previously learned background of meaningful ideas and information. In fact, the curriculum is deliberately organized in this fashion to provide for the untraumatic introduction of new facts, concepts, and propositions. Rotely learned materials, on the other hand, are discrete and relatively isolated entities that are relatable to cognitive structure only in an arbitrary, verbatim fashion, not permitting the establishment of the above-mentioned relationships.

This crucial difference between rote and meaningful learning categories has important implications for the kind of learning and retention processes underlying each category. Since rotely learned materials do not interact with cognitive structure in a substantive, organic fashion, they are learned and retained in conformity with the laws of association, and their retention is influenced primarily by the interfering effects of *similar* rote materials learned *immediately* before or after the learning task. Learning and retention outcomes in the case of meaningful learning, on the other hand, are influenced primarily by the properties of those relevant and cumulatively established ideational systems in cognitive structure with which the learning task interacts and which determine its dissociability strength. Compared to this kind of extended interaction, concurrent interfering effects have relatively little influence on and explanatory value for meaningful learning.

### *Meaningful Learning Processes*

Substantive and nonarbitrary incorporation of a potentially meaningful learning task into relevant portions of cognitive structure so that a new meaning emerges, implies that the newly learned meaning becomes an integral part of a particular ideational system. The possibility of this type of relatability to and incorporability into cognitive structure has two principal consequences for learning and retention processes. First, learning and retention are no longer dependent on the rather frail human capacity for retaining arbitrary and verbatim associations as discrete and isolated entities in their own right. As a result, the temporal span of retention is greatly extended.

Second, the newly learned material becomes subject to the organizational principles governing the learning and retention of the system in which it is incorporated. To begin with, the very act of incorporation requires appropriate (relevant) placement within a hierarchically organized system of knowledge. Later, after incorporation occurs, the new material initially retains its substantive identity by virtue of being dissociable from its anchoring ideas, and then gradually loses its identifiability as it becomes reduced to and undissociable from these ideas

In this type of learning retention process, the formation and strengthening of arbitrary associative bonds between discrete, verbatim elements, isolated in an organizational sense from established ideational systems, play little if any role The important mechanisms involved in this process are (a) achievement of appropriate relational anchorage within a relevant ideational system, and (b) retention of the identifiability (dissociability) of the newly learned material Such retention involves resistance to the progressively increasing inroads of obliterative assimilation or loss of dissociability, and characterizes the organization and long term memorial integrity of meaningfully learned materials in cognitive structure

### *Rote Learning Processes*

It has already been pointed out that rote learning tasks *are* relatable to cognitive structure in an arbitrary, verbatim fashion and that it is by virtue of this relatability that (a) already meaningful components of these tasks are perceived as such and thereby facilitate rote learning and (b) concurrent interference with rote learning arises from within cognitive structure However, the extreme arbitrariness of the learning task's relatability to ideational systems within cognitive structure (as well as the necessity for *verbatim* internalization and reproducibility) precludes the relational and substantive type of incorporation described above for meaningful learning and makes for a basically different kind of learning retention process Rote learning tasks can be incorporated into cognitive structure only in the form of arbitrary associations that is as discrete, self contained entities organizationally isolated for all practical purposes from the learner's established ideational systems The requirement that these arbitrary associations be constituted on a verbatim rather than substantive basis (since anything less than complete verbatim fidelity is valueless in the case of purely arbitrary associations) further enhances the discreteness and isolated nature of rotely incorporated entities

One important implication of the discrete and isolated incorporation of rote learning tasks within cognitive structure is that quite unlike the situation in meaningful learning anchorage to established ideational systems is not achieved Hence since the human mind is not efficiently designed for long term verbatim storage of arbitrary associations the retention span for rote learnings is relatively brief The much steeper gradient of forgetting in the case of rote as compared to meaningful learning requires that we examine the rote retention process and the factors that influence it within a highly abbreviated time span Delay beyond this brief time span leaves us with nothing to study

A second important implication of the arbitrary verbatim incorporation of learning material within cognitive structure is that *association* necessarily constitutes the basic learning retention mechanism and the laws of association constitute by definition the basic explanatory principles governing rote learning and retention The major goals of rote learning and retention therefore are to increase and maintain associative strength—not to achieve appropriate anchorage and to preserve dissociability strength Such variables as contiguity frequency and reinforcement are accordingly crucial for learning and retention is influenced primarily by concurrent interference (of both internal and external origin) on the basis of intra and inter task similarity response competition and stimulus and response generalization

## *Evidence of Meaningful Learning*

It is not always easy to demonstrate that meaningful learning has occurred Genuine understanding implies the possession of clear precise differentiated and transferable meanings But if one attempts to test for such knowledge by asking students to state the criterial attributes of a concept or the essential elements of a proposition one may merely tap rotely memorized verbalizations At the very least therefore tests of comprehension must be phrased in different language and must be presented in a somewhat different context than the originally encountered learning material Perhaps the simplest way of doing this is to require students to differentiate between related (similar) but not identical ideas or to choose the identifying elements of a concept or proposition from a list containing those of related concepts and propositions as well

Independent problem solving is often the only feasible way of testing whether students *really* comprehend meaningfully the ideas they are able to verbalize But here we have to be careful not to fall into a trap To say that problem solving is a valid practical method of measuring the meaningful comprehension of ideas is *not* the same as saying that the learner who is unable to solve a representative set of problems *necessarily* does not understand but has merely rotely memorized the principles exemplified by these problems Successful problem solving demands many *other* abilities and qualities such as reasoning power perseverance flexibility improvisation problem sensitivity and tactical astuteness in *addition* to comprehension of the underlying principles Hence failure to solve the problems in question may reflect deficiencies in these latter factors rather than lack of genuine understanding or at the very worst it may reflect a lower order of understanding than that manifested in ability successfully to apply the principles in problem solving Another feasible method of testing the occurrence of meaningful learning which does not involve this difficulty of inter pretation is to present the learner with a new, sequentially dependent learning passage that cannot possibly be mastered in the absence of genuine understanding of the prior learning task This technique will be discussed in more detail later

In seeking evidence of meaningful learning, whether through verbal questioning or problem solving tasks, the possibility of rote memorization should always be borne in mind Long experience in taking examinations makes students adept at memorizing not only key propositions and formulas, but also causes, examples, reasons, explanations, and ways of recognizing and solving 'type problems" The danger of rote simulation of meaningful comprehension may be best avoided by asking questions and posing problems that are both novel and unfamiliar in form and require maximal transformation of existing knowledge

### *The Superiority of Meaningful Learning and Retention*

Several lines of evidence point to the conclusion that meaningful learning and retention are more effective than their rote counterparts First, M G Jones and H B English (1926) and L J Briggs and H B Reed (1943) demonstrated that it is much easier meaningfully to learn and remember the substance of potentially meaningful material than it is to memorize the same connected material in rote, verbatim fashion Second, material which can be learned meaningfully (poetry, prose, and observations of pictorial matter) is learned much more rapidly than are arbitrary series of digits or nonsense syllables (Glaze 1928 Lyon, 1914, H B Reed, 1938) The same difference holds true for gradations of meaningful learning simple narrative material is learned more quickly and remembered better than are more complex philosophical ideas that are difficult to understand (H B Reed, 1938) An increase in the amount of material to be learned also adds relatively less learning time to meaningful than to rote learning tasks (Cofer 1941, Lyon, 1914) A third type of experimental evidence is derived from studies demonstrating that various problem solving tasks (card tricks, match stick problems) are retained longer and are more transferable when subjects learn underlying principles rather than rotely memorize solutions (Hilgard, Irvine, and Whipple, 1953 Katona, 1940)

A related line of evidence showing that substance items are learned (Cofer, 1941) and retained (Edwards and English 1939, English, Welborn, and Kilian, 1934, E B Newman 1939) more effectively than are "verbatim' items is more inferential than direct Presumably although verbatim items can be learned meaningfully, they are more likely to be memorized rotely than are concepts and generalizations In this connection, an ingeniously designed study by E B Newman (1939) comparing retention during periods of sleep and waking throws light on the relative retention spans and respective forgetting processes of rotely and meaningfully learned materials Unessential details of a narrative were remembered much better after a period of sleep than after a period of normal daily activity, whereas there was no corresponding difference in the case of substance items A warranted inference here is that immediate retroactive interference, which is obviously greater during daily activity than during sleep, is an important factor in rote memory, but does not significantly affect the retention of meaningfully learned materials

Many classroom studies support the findings of this last mentioned experimental approach In general, they show that principles, generalizations, and applications of principles studied in such courses as biology, chemistry, geometry, and physics are remembered much better over periods of months and even years than are more factual items such as symbols formulas, and terminology (Eikenberry, 1923, Frutchey, 1937, R W Tyler, 1930, 1934b, Ward and Davis 1938) A second type of classroom evidence demonstrates that knowledge of number facts (addition, subtraction, multiplication and division) learned with understanding is retained more effectively and is more transferable than when learned in mechanical, rote fashion (G L. Anderson 1949, Brownell and Moser, 1949, T R McConnell, 1934, E J Swenson, 1949, Thiele, 1938)

Both types of evidence encourage one to believe that the discouraging picture of forgetting the vast majority of subject matter learnings, which certainly characterizes most students today, is not necessarily inevitable Much of this loss is reflective of rote learning of poorly organized and programmed subject matter, of correctable ambiguity and confusion in the presentation of ideas and of inadequate pacing and review of material (cramming) If subject matter were adequately organized and programmed, if material were presented lucidly if misconceptions were corrected promptly, and if suitably motivated students learned meaningfully and paid attention to such considerations as optimal review and pacing there is good reason to believe that they would retain over a lifetime most of the important ideas they learned in school At the very least one would expect them to be able to relearn, in short order and with relatively little effort, most of what they had forgotten In subsequent chapters we shall examine the important cognitive structure practice instructional material and motivational variables that affect the longevity of meaningfully learned subject matter

Many different kinds of explanations have been offered for the superiority of meaningful over rote learning and retention One explanation identifies meaningful learning with the learning of meaningful material, and advances all of the arguments referred to above in explaining why meaningfulness facilitates rote verbal learning Our definition of meaningful learning however, implies that it is a characteristic *process* in which mean ing is a *product* or outcome of learning rather than primarily an attribute of the content of what is to be learned It is this process rather than the meaningfulness of the content[5] which is learned that characterizes meaningful learning Thus the same reasons that explain why *more* meaningful materials are *rotely* learned and retained more readily than *less* meaningful materials are, do not necessarily explain why meaningful learning and retention outcomes are superior to their rote counterparts

Gestalt theorists (Katona, 1940, Koffka, 1935), on the other hand, identify insight and the understanding of relationships with the establishment of stable 'structural traces, which are contrasted, in turn, with the relatively "rigid and unstable discrete traces established by rotely memorized materials This explanation, however, really begs the question, because it accounts for the superiority of meaningful learning processes simply by endowing the neural representation of these processes with superior potency In effect, then, it is claimed that meaningful learning processes yield superior learning outcomes because they give rise to more stable traces This obviously adds little to our understanding because the real problem is to understand why such processes are associated with more stable traces

In accounting for G Katona's research findings that meaningfully learned solutions to problems are retained more effectively than rotely learned solutions C E Osgood (1953) offers a typical neobehavioristic explanation He states that the understanding of relationships reduces the sheer volume of what has to be remembered by rendering the details of the learning task reconstructable from memory of the principle itself It is undeniable, of course, that the burden on memory is substantially less if one

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[5] It was also pointed out earlier that in meaningful learning the materials are not *already* meaningful but only *potentially* meaningful The very object of meaningful learning is to convert potential meaning into actual (psychological) meaning *Both* rotely and meaningfully learned tasks contain already meaningful components but in the first instance the task *as a whole* is not potentially meaningful whereas in the second instances it is The presence of the already meaningful components therefore is at most an *indirect* factor accounting for the superior learning (rote or meaningful) that occurs when such components are included in the task It cannot possibly account for the superiority of meaningful over rote learning with respect to the task as a whole The more important reason for the superiority of meaningful over rote learning obviously inheres in the fact that in meaningful learning the task as a whole is potentially meaningful and therefore can be nonarbitrarily and substantively related to cognitive structure

That meaningful learning primarily refers to a distinctive *process* of learning rather than to the meaningfulness of the content that is learned is further highlighted by the fact that both the meaningful learning process and its outcome can be rote—even when the learning task as a whole is potentially meaningful—if the learner does not manifest a meaningful learning set need only remember the substance of a connected and potentially meaningful proposition than if one must remember the verbatim content of a series *of discrete, arbitrarily related* verbal *items* or of connected nonsense material This is undoubtedly *one* of the factors accounting for the superiority of meaningful over rote learning A more important reason for the greater stability of meaningful learning however, inheres in the nonarbitrary and substantive relatability and anchorability of meaningfully learned material to relevant established ideas in cognitive structure Hence, not only is there less content to learn and remember, but there is also a more tenable and stable basis for learning and retaining that content which has to be assimilated The two explanations are by no means mutually exclusive

It should be noted, however, that although rote learning is more difficult than meaningful learning in most circumstances, it may actually be easier for the individual who lacks the necessary ideational background for a particular learning task In addition to the anxiety ridden person who lacks confidence in his ability to understand difficult and unfamiliar new propositions rote learning often *appears* easier than meaningful learning

MEANINGFUL VERSUS ROTE RETENTION Does the superiority of meaningful over rote retention reflect an actual difference in the efficacy of the respective *retention* processes or does this superiority merely reflect the greater efficacy of meaningful *learning?* Obviously, if meaningfully learned material is mastered better to begin with more incorporated meanings are available at any subsequent time when retention is tested—even if rote and meaningful retention processes themselves are equally efficacious In the case of *rote* learning of materials varying in degree of meaningfulness it has been demonstrated that *learning* is the only important variable When more and less meaningful materials are learned to the same criterion of mastery (by allowing a greater number of trials for the less meaningful material) they do not differ in retention outcomes (Postman and Rau, 1957, Underwood and Richardson 1956)

If however our theory regarding the existence of fundamental differences between *rote and meaningful retention* processes is correct, we would *not* expect that if rotely and meaningfully learned materials were mastered equally well they would also be remembered with equal effectiveness According to assimilation theory the same variables influencing the outcome of meaningful learning and the same factors accounting for the superiority of meaningful over rote learning processes *continue* to operate during the retention interval and to affect retention outcomes Hence even if rotely and meaningfully learned materials were learned to the same criterion of mastery the superiority of the meaningful retention process would be reflected in higher retention scores Unfortunately, however, research evidence is not presently available to test the validity of this proposition Comparative studies of rote and meaningful retention are needed that are analogous to the research described above on the rote retention of materials varying in degree of meaningfulness

## Alternative Theories of Retention and Forgetting

### *Interference Theory*

From a neobehavioristic standpoint

> a memory is nothing more than a response produced by a stimulus [It] is merely the maintained association of a response with a stimulus over an interval of time [Hence] the question of why we forget comes down to this What are the conditions under which stimuli lose their capacity to evoke previously associated responses In other words the problem of forgetting is identical with the causes of response decrement Forgetting is a direct function of the degree to which substitute responses are associated with the original stimuli during the retention interval This [is really] a definition of retroactive interference Identity between responses in original and interpolated activities yields facilitation whereas difference between responses yields interference (forgetting) and the magnitude of either facilitation or interference is a function of the stimulus similarities between original and interpolated activities (Osgood 1953 pp 550 551)

The following kinds of behavioristic mechanisms have been proposed to account for retroactive interference (a) *response competition* the same stimulus associated with a given response during original learning becomes associated during the retention interval with a stronger competing response, (b) *stimulus generalization* a response associated with a given stimulus during original learning generalizes to other stimuli during the retention interval, (c) *response generalization* a stimulus associated with a given response during original learning generalizes to similar responses during the retention interval, (d) *unlearning* the failure of the learner to make the initially learned responses when confronted by the relevant stimuli during the interval between learning and recall, (e) *changed cues* either some of the stimuli present during original learning are absent during recall, or new stimuli evoking competing responses are present and (f) *changed set* alteration during recall of the set established during learning

Evidence favoring the interference theory of forgetting comes from studies of rote learning showing that the degree of forgetting is directly related to the amount and similarity of activities interpolated during the interval between original learning and recall When interpolated activity is reduced by such conditions as sleep (Jenkins and Dallenbach, 1924, E B Newman, 1939, Van Ormer, 1932), hypnosis (Nagge, 1935, Rosenthal, 1944), anesthesia (Summerfield and Steinberg 1957), and immobilization (Minami and Dallenbach, 1946) retroactive interference decreases, and when the amount and similarity of interpolated activity increases, retroactive interference correspondingly increases (McGeoch, 1936 McGeoch and McGeoch, 1937, Melton and Irwin, 1940, Twining 1940, Underwood, 1945) However, B J Underwood's reinterpretation of the relevant data of many studies indicates that most forgetting of rotely learned material is 'produced by interference—*not* from tasks learned *outside* the laboratory but from tasks learned *previously* in the laboratory, [and] that when interference from laboratory tasks is removed, the amount of forgetting is relatively quite small (Underwood, 1957, p 51) But identifying the source of the interference with rote retention as being principally proactive rather than retroactive does not alter in any fundamental way either the basic premises or the validity of interference theory

*Interference theory has little difficulty in explaining rote* verbal learning and forgetting The learning of discrete verbal units isolated from cognitive structure can be conceived of quite plausibly in terms of habit (associative) strength, and forgetting can be similarly conceptualized in stimulus-response terms as reflective of interference with established habit strength through such mechanisms as response competition and stimulus or response generalization Specific responses purportedly become unavailable because they are superseded by competing associative tendencies with greater relative strength Hence, the principal variable in rote forgetting is exposure, shortly before (proactive interference) or after (retroactive interference) the learning session to materials similar to but not identical with the learning task

But when material is *meaningfully* learned (that is, interacts substantively with established ideas in cognitive structure instead of forming a series of arbitrary and discrete associative tendencies), it seems more credible to define learning and retention in terms of the dissociability of the material from its anchoring ideas at successive stages in an interactional process In relation to this theoretical frame of reference, the major variables affecting learning and retention are the availability of relevant anchoring ideas in cognitive structure (Ausubel 1960, Ausubel and Fitzgerald, 1961) the stability and clarity of these ideas (Ausubel and Fitzgerald, 1962), and the discriminability of the learning material from its anchoring ideas (Ausubel and Fitzgerald 1961 Ausubel and Youssef 1963) Thus the resistance of meaningfully learned material to forgetting is not a simple function of the relative strength of specific associative tendencies compared to other similar tendencies but is a function of its dissociability from the ideational system to which it is related Instead of mechanical interference from a similar trace there is substantive assimilation within an ideational common denominator

The inapplicability of behavioristic principles of proactive and retroactive interference to meaningfully learned verbal materials becomes evident when we study retention after meaningful learning has occurred As already pointed out verbatim but not substance items are forgotten after a period of normal waking activity (E B Newman, 1939), and explicit study of a long passage about Christianity, immediately before or after the learning of a comparable passage about Buddhism, does not significantly impair the im mediate or delayed Buddhism retention scores of college students in com parison with those of matched control subjects not exposed to the Chris tianity material (Ausubel and Blake, 1958, Ausubel, Robbins, and Blake, 1957a) Similar findings were obtained by J F Hall (1955) with meaning fully learned material Retroactive interference is generally found only when verbatim recall of the potentially meaningful material is demanded (Jenkins and Sparks, 1940, King and Cofer, 1960, Slamecka, 1959b, 1960, 1962)

The short term interference of similar elements, so crucial in rote for getting becomes relatively insignificant when potentially meaningful mate rials are related to established anchoring concepts and progressively interact with them to the point of obliterative assimilation Under these conditions the discriminability of the Buddhism from the Christianity material and the clarity and stability of the learner s knowledge of Christianity are the sig nificant determining variables (Ausubel and Blake 1958, Ausubel and Fitz gerald 1961 Ausubel and Youssef 1963) The same studies also showed that retroactive learning of material with the same ideational import as the learning passage but differing in specific content, sequence, and mode of presentation not only has no inhibitory effect on retention but is just as facilitating as repetition of the learning passage (Ausubel, Robbins, and Blake, 1957a) Meaningfully—(unlikely rotely—) learned materials obviously have a general substantive content that is transferable or independent of specific verbatim form and sequence

A recent study by Entwisle and Huggins (1964) using principles of elec trical circuit theory as learning material suggested that when *both* the orig inally learned material *and* the material interpolated between the learning and retention of the original material are unfamiliar or relatively unstable, and when the two sets of material are also sufficiently similar to each other to engender conflict and confusion, retroactive interference may occur even under conditions of *apparently meaningful* learning Repetition of this study with verbal materials less susceptible to rote memorization of formulas however, failed to confirm their findings In fact, the interpolation of con flicting material actually facilitated the retention of the original material (Ausubel and others in press) presumably by increasing the clarity and discriminability of the original material The retroactive interference found by D R Entwisle and W H Huggins could conceivably be attributed to the fact that much of the learning of the electrical circuit material was rote in character

To summarize, the assimilation theory of retention differs from the interference theory in defining retention in terms of the dissociability of an ideational element from its anchoring ideas rather than in terms of the freedom of discrete and arbitrary associations from the interfering effects of concurrently active rote elements Assimilation theory takes into account the existing hierarchical organization of meaningfully learned materials in cognitive structure the incorporation of new potentially meaningful material within that structure and the tendency for the new material to be reduced to a least common denominator of relevant established meanings Unlike behavioristic concepts of interference which postulate an association that is modified only at those points in time when members of the association are utilized (Osgood 1953 p 547) the assimilation process once initiated occurs continuously until the point of zero dissociability is reached In view of these differences and of the marked disparity between the respective retention spans of *rotely and meaningfully learned materials* it hardly seems likely that the same type of retention process could characterize rote and meaningful learning

## *Gestalt Theory*

According to Gestalt theory (Koffka 1935) forgetting is brought about by two principal mechanisms each of which has relatively little in common with the other The first mechanism *assimilation* is conceptualized as a process whereby memory traces are obliterated or replaced by similar traces in cognitive structure that are relatively more stable Although this phenomenon is superficially similar to the assimilative process described above in that it seems to imply *fusion* of or interaction between related ideas rather than the substitution of new stimulus or response members in a previously learned stimulus-response association it is actually more congruent with the interference theory of forgetting The behavioristic mechanisms of response competition and stimulus or response generalization could quite adequately account for the occurrence of Gestalt assimilation

The second more distinctively Gestalt mechanism of forgetting is conceptualized as a process of *autonomous disintegration* within traces In the case of unstructured or poorly organized material (for example where figure and ground are poorly differentiated) unstable chaotic traces are formed which rapidly undergo a type of spontaneous decay In other instances however dynamic stresses derived from the original perception persist in the trace and are gradually resolved by such progressive changes as leveling and sharpening in the direction of *closure symmetry and good form* Thus both this aspect of Gestalt theory and our assimilation theory of forgetting differ from the interference theory in regarding the processes underlying forgetting as occurring continuously rather than only during those times when the stimulus or response members of an association are exercised. The Gestalt theory, however, is less parsimonious since it ignores the role of previously learned and more stable ideas both in the learning process and in determining the direction of forgetting. It postulates instead that (a) new ideas do not interact with relevant established ideas in cognitive structure but, rather, are incorporated as independent traces, and (b) these separate traces spontaneously undergo change in the direction of "more perfect" or "less stressful form." Also, as pointed out above, the hypothesis that "poorly organized" materials are forgotten quickly because they form "chaotic traces" which undergo rapid "spontaneous decay" really begs the question.

Our assimilation theory differs from Gestalt theory in the following important ways: (a) It attributes *all* forgetting to interaction between the learning material and existing cognitive structure and denies that autonomous disintegration of traces occurs as a result of the resolution of perceptually derived intra-trace tensions. Asymmetrical figures, for example, would sometimes be remembered as more symmetrical than originally perceived ("leveling"), not because of any autonomous changes within the trace, but because they are subsumed by and eventually reduced to a memorial residue of familiar geometrical concepts in cognitive structure. (b) It conceives of assimilation (loss of identifiability or decreased dissociability of newly learned materials) as a *progressive* phenomenon rather than as an all-or-none type of replacement in which availability is lost completely and instantaneously. The obliterative or reductionistic aspect of assimilation is also regarded as only the *mechanism* accounting for forgetting; the net effect of the anchoring process itself *facilitates* retention. (c) Thus the forgetting attributable to assimilation is not conceived of as simple and abrupt *replacement* of one trace by another more stable trace (as in interference theory), but as the outcome of a gradual trend toward memorial reduction. As a result of this trend, a highly inclusive and established ideational system comes to represent the import of less generalized ideas, the identifiability of which is correspondingly obliterated. (d) Learning material is believed to be assimilated by a more established ideational system not because of *similarity between them*, but because it is not sufficiently discriminable from that system. Hence its import can be adequately represented by the generality of the more established ideas. Similarity, of course, helps determine which potentially anchoring ideas in cognitive structure actually play principal and subsidiary anchoring roles and is also one of the determinants of discriminability. A high degree of similarity, however, can facilitate initial anchorage without necessarily leading rapidly to obliterative assimilation, provided that differences are also clearly and explicitly understood. (e) Forgetting is regarded as a continuation of the *same interactional process* established at the moment of learning. According to Gestalt assimilation theory, on the other hand, a given trace is first established at the time of learning and then interacts with and is later replaced by *another* similar and separately established trace

### *Bartlett's Theory of Memory*

Assimilation theory also has elements in common with F C Bartlett s (1932) views of cognitive functioning generally and of remembering in par ticular He conceptualizes a *schema* as an organizing and orienting attitude or affect resulting from the abstraction and articulation of past experience Although somewhat vague with respect to both nature and mode of opera tion it is structurally and functionally comparable to that of an anchoring idea *In general however, Bartlett s position on retention differs in two* fundamental respects from assimilation theory First, the schema itself is largely attitudinal and affective in nature rather than basically cognitive, in this sense it is similar to the connotative aspects of meaning This differ ence probably reflects in part the fact that Bartlett s learning tasks consist of stories, pictures and figures instead of the impersonal substance of subject matter content Second, Bartlett is primarily concerned with the inter pretive and reproductive phases of meaningful learning and retention, and pays hardly any attention at all to the retention interval itself and its under lying processes

Thus in accounting for the discrepancy between presented and remem bered content he emphasizes both (a) the influence of idiosyncratic and culturally biased schemata on the original *perception* of the material, and (b) a process of imaginative reconstruction at the time of recall, as a result of which particular content is selected and invented in accordance with the nature and requirements of the current situation Assimilation theory, on the other hand attributes most forgetting to an intervening interactional process involving anchoring ideas and assimilated content Thus, although the individual in remembering undoubtedly selects from what is available in memory and also invents some new material suitable for the occasion, he is actually *reproducing*, for the most part, materials that have undergone memorial reduction rather than *reconstructing* the retained residue of orig inal meanings

According to Bartlett the first opportunity for schemata to influence memory occurs when they interact with incoming stimulus content The subject attempts to make the content meaningful *in terms of a relevant* schema as well as contextually consonant with it Hence, schemata signif icantly determine the initial interpretation of the message, which in turn persistently influences the nature of what is retained Contrary to Bartlett s contention however, this interpretive process which results in the emer gence of meaning is *cognitive* rather than perceptual in nature Newly acquired meanings are not reflective of a perceptual process that yields an immediate content of awareness, but rather are products of a more complex cognitive process of assimilation Meanings are idiosyncratic, therefore, not because an attitudinal schema selectively influences the *perception* of learning material, but because such material is nonarbitrarily and substantively selectively related to the idiosyncratic content of individual cognitive structures (a *learning* process)

The importance of initial interpretation (acquisition of meaning) for the later reproductive content of memory has been demonstrated for both verbal (Jones and de Charms 1958, Kay, 1955, McKillop, 1952) and pictorial (Carmichael, Hogan and Walter, 1932) material Subjects are prone to acquire meanings that are compatible with their own attitudinal biases in reading ambiguous controversial materials (McKillop, 1952), and tend to interpret the hypothetical behaviors of people in accordance with the selective emphases embodied in experimentally manipulated advance sets (Jones and de Charms 1958) Children are generally unable to remember a figure unless it reminds them of a familiar object (Granit, 1921), and in reproducing unfamiliar and meaningless figures they alter them in ways that increase their familiarity and meaningfulness (Hildreth, 1944) The same tendency is also evident in problem solving Learners consistently tend to reduce problems to a level of difficulty which they can understand and make meaningful (Hildreth 1941) In studying qualitative changes in retention, therefore, it is important to use the immediate reproduction rather than the learning material itself as the baseline

Bartlett largely ignores the next phase of the learning retention sequence during which acquired meanings are retained He states that the schema s principal impact on memory occurs during the *reproductive* phase At this time the subject differentially selects those elements that are both most consistent with his own attitudes interests and cultural milieu and also most appropriate in terms of the requirements of the current situation To this he adds some invented detail (to fill in gaps and to enhance coherence, meaningfulness, and fit ) and combines and reformulates both kinds of elements into a new, self consistent whole The reconstructed product, therefore, when compared to the original learning material, manifests such tendencies as simplification condensation rationalization, conventionalization and importation R M Dawes (1966) A S McKillop (1952), M L Northway (1936) I H Paul (1959) R Taft (1954) and M E Tresselt and S O S Spragg (1941) report similar findings in the recall of value laden narrative material The weakness of Bartlett s position therefore, does not inhere in postulating the existence of imaginative reconstruction, but rather in the fact that many of the memorial changes he attributes to such reconstruction actually reflect changes in availability due to assimilation

### *Psychoanalytic Theory*

Psychoanalytic theory maintains that *all* forgetting is motivated or in other words is a product of repression Ideas or impulses that would generate anxiety if permitted to enter consciousness are said to be repressed into the unconscious and thereby forgotten

The chief difficulty with this theory of course is that it accounts at best for a relatively rare type of forgetting Only a very small percentage of the ideas that are forgotten are in any sense productive of anxiety and in these instances it is more parsimonious to hypothesize that their threshold of availability is elevated rather than that they are banished into a reified topographical area of the mind It is also true that many anxiety producing ideas remain painfully and obsessively at the forefront of consciousness

### *Computer Models of Cognitive Functioning*

An increasingly popular theoretical position in recent years has been a variant of the cybernetic or information theory approach based on a computer model of cognitive organization and functioning It combines various postulated mechanisms of computer based information processing and storage with the cybernetic principle of a control system This control system is regarded both as sensitive to feedback indicative of behavioral error (or of discrepancy between existing and desired states of affairs) and as differentially responsive to such feedback in ways that correct the existing error or discrepancy The particular model of human thinking proposed by A Newell J C Shaw and H A Simon (1958) for example assumes the existence of receptors capable of interpreting coded information and of a control system consisting of a store of memories a variety of processes which operate on the information contained in the memories and a set of rules for combining these latter processes into programs of processing

The theoretical value of the computer model view depends of course on the tenability of the particular theories of information processing proposed by theorists of this persuasion to account for human cognitive functioning Computer programs certainly seem capable of performing many of the same kinds of cognitive operations performed by humans—memorizing generalizing categorizing problem solving and logical decision making The crucial question is whether human beings perform these operations by means of the *same underlying processes* imputed to computer models

The processes underlying the operations involved in most computer models of cognitive functioning are incredibly simple when compared to the awesome complexities of the actual processes implied by relevant psychological considerations Hence the postulated parallelism between the two sets of processes breaks down at innumerable points of comparison. In the first place, computers are able to process and store vast quantities of discrete units of information that are simultaneously or sequentially presented. Human beings can assimilate and remember only a few discrete items at a time. They compensate for this limitation by "chunking" (G. A. Miller, 1956), by processing larger units composed of sequentially dependent items, by learning generic codes that subsume specific derivative instances (derivative subsumption), and by cataloguing new information under more inclusive subsumers (correlative subsumption).

Second, computers have no forgetting problem. There is no possibility of obliterative assimilation or of proactive or retroactive interference. Information stored in a computer maintains its availability indefinitely; the entire notion of dissociability strength, of progressive loss of such strength, and of the dependence of rate of loss on such factors as discriminability and the clarity and stability of anchoring ideas, makes little sense in the context of computer memory. Third, there is no problem of developmental change in connection with computers. They do not change with age in capacity for assimilating and storing information or in the kinds of information processing or problem solving processes they employ. Lastly, as presently engineered computers lack the human being's capacity for imaginative improvisation, for creative inspiration, and for independent thinking.

# COGNITIVE FACTORS IN LEARNING

Chapter 4

# COGNITIVE STRUCTURE AND TRANSFER

HAVING CONSIDERED THE NATURE OF MEANING and meaningful learning as well as the nature of reception learning and retention we are now in a position to discuss cognitive factors in classroom learning Among these factors the existing structure of knowledge at the time of learning (cognitive structure variables) is perhaps the most important consideration Since this involves by definition the impact of prior experience on current learning processes it is synonymous with the problem of transfer How can the influence of this factor be distinguished from that of developmental readiness which will be discussed in Chapter 5? What are the principal cognitive structure variables and how do they affect meaningful learning and retention? What pedagogic measures can the teacher take to maximize the influence of transfer or the effect of cognitive structure variables on current classroom learning? What about individual differences in cognitive functioning ( cognitive style )? What is the relationship between language and transfer?

## The Role of Cognitive Structure in Meaningful Learning and Retention

It follows from the very nature of accretion to the psychological structure of knowledge through the assimilation process that *existing cognitive structure itself*—both the substantive content of an individual s structure of knowledge and its major organizational properties in a particular subject matter field at any given time—is the principal factor influencing meaningful learning and retention in this same field Since logically meaningful material is always, and can only be, learned in relation to a previously learned background of relevant concepts, principles and information which make possible the emergence of new meanings and enhance their retention, it is evident that the substantive and organizational properties of this background crucially affect both the accuracy and the clarity of these emerging new meanings and their immediate and long term retrievability If cognitive structure is clear, stable, and suitably organized, accurate and unambiguous meanings emerge and tend to retain their dissociability strength or availability If, on the other hand, cognitive structure is unstable, ambiguous, disorganized, or chaotically organized, it tends to inhibit meaningful learning and retention Thus, it is largely by strengthening relevant aspects of cognitive structure that new learning and retention can be facilitated

It is, therefore, a commonplace that the details of a given discipline are learned as rapidly as they can be fitted into a contextual framework consisting of a stable and appropriate body of general concepts and principles When we deliberately attempt to influence cognitive structure so as to maximize meaningful learning and retention, we come to the heart of the educative process

In our opinion the most significant advances that have occurred in recent years in the teaching of such subjects as mathematics, chemistry, physics, and biology have been predicated on the assumption that efficient learning and functional retention of ideas and information are largely dependent upon the adequacy of cognitive structure And since existing cognitive structure reflects the outcome of all previous assimilation processes it, in turn, can be influenced, *substantively*, by the inclusiveness and integrative properties of the particular unifying and explanatory principles used in a given discipline, and, *programmatically*, by methods of presenting arranging, and ordering learning materials and practice trials

## Cognitive Structure and Transfer

We have just hypothesized that past experience influences, or has positive or negative effects on, new meaningful learning and retention by virtue of its impact on relevant properties of cognitive structure. If this is true, all meaningful learning necessarily involves transfer because it is impossible to conceive of any instance of such learning that is not affected in some way by existing cognitive structure, and this learning experience, in turn, results in new transfer by modifying cognitive structure In meaningful learning therefore cognitive structure is always a relevant and crucial variable, even if it is not deliberately influenced or manipulated so as to ascertain its effect on *new* learning For example, in those short term learning situations where just a single unit of material is learned and transfer to new learning units is not measured, the effects of even a single practice trial both reflect the influence of existing cognitive structure and induce modification of that structure, thereby affecting subsequent practice trials

School learning requires, much more saliently than do laboratory types of learning situations, the incorporation of new concepts and information into an existing and established cognitive framework with particular organizational properties The transfer paradigm still applies here, and transfer still refers to the impact of prior experience upon current learning But prior experience in this case is conceptualized as a cumulatively acquired, hierarchically organized, and established body of knowledge which is organically relatable to the new learning task, rather than as a recently experienced constellation of stimulus response connections influencing the learning of another discrete set of such connections

Furthermore, the relevant aspects of past experience in this type of transfer paradigm are such organizational properties of the learner s subject matter knowledge as clarity, stability, generalizability, inclusiveness, cohesiveness, and discriminability—rather than degree of similarity between stimuli and responses in the two learning tasks, and recent experience is regarded as influencing current learning not by interacting *directly* with the stimulus response components of the new learning task, but only insofar as it modifies significant relevant attributes of cognitive structure

Because training and criterion tasks in laboratory studies of transfer have usually been separate and discrete, we have tended to think in terms of how prior task *A* influences performance on criterion task *B* If performance has been facilitated in comparison with that of a control group which had not been exposed to task *A*, we say that positive transfer has occurred Actually, however, in typical classroom situations, *A* and *B* are not discrete but continuous *A* is a preparatory stage of *B* and a precursive aspect of the same learning process *B* is not learned discretely but in relation to *A* Hence, in school learning we deal not so much with transfer in the literal sense of the term as with the influence of prior knowledge on new learning in a continuous sequential context This latter learning context also typically involves correlative superordinate, or combinatorial assimilation Thus, as pointed out above, the relevant transfer effect with which we are usually concerned is not the ability to reconstruct forgotten details from generic principles, or to recognize new phenomena as specific variants of these principles (derivative subsumption), but rather the enhanced ability to learn and retain correlative, superordinate or combinatorial material

Moreover, unlike J S Bruner s (1960) nonspecific transfer," the kind of transfer just described is not restricted to those instances in which ' a general idea can be used as a basis for recognizing subsequent problems as special cases of the ideas originally mastered."[1] Actually, the principal effect of existing cognitive structure on new cognitive performance is on the learning and retention of newly *presented* materials where potential meanings are *given*—not on the solution of problems requiring the application and reorganization of cognitive structure to new ends. Thus a transfer situation exists whenever existing cognitive structure influences new cognitive functioning, irrespective of whether it is in regard to reception learning or problem solving.

## Principal Cognitive Structure Variables

The learner's acquisition of a clear, stable, and organized body of knowledge constitutes more than just the major long-term objective of classroom learning activity or the principal *dependent* variable (or criterion) to be used in evaluating the impact of all factors impinging on learning and retention. This knowledge (cognitive structure) once acquired, is *also* in its own right the most significant *independent* variable influencing the learner's capacity for acquiring more new knowledge in the same field. The importance of cognitive structure variables, however, has been generally underestimated in the past because preoccupation with noncognitive, rote, and motor kinds of learning has tended to focus attention on such situational and intrapersonal factors as practice, drive, incentive, and reinforcement variables. But in searching for knowledge about the processes underlying meaningful reception learning and retention, it is not enough to stress the importance of relevant antecedent experience that is represented in existing cognitive structure. Before fruitful experimentation can be attempted, it is necessary to specify and conceptualize those properties (variables) of cognitive structure that influence new learning and retention.

R. M. Gagné puts it this way:

> The presence of [a] performance does not make it possible to conclude that learning has occurred. It is necessary to show that there has been a *change in performance*. The incapability for exhibiting the performance *before* learning must be taken into account as well as the capability that exists after learning. It is, in fact, the existence of prior capabilities that is slighted or even ignored by most of the traditional learning prototypes. And it is these prior capabilities that are of crucial

[1] Gagné (1962a) also views knowledge as the *capability* of performing different classes of problem-solving tasks once a subordinate set of capabilities in the hierarchy are mastered. In contrast, we have viewed knowledge as a substantive (ideational) phenomenon rather than as a problem-solving capability, and have regarded the transfer functions of cognitive structure as applying more significantly to reception learning than to problem solving in the typical classroom situation.

importance in determining the conditions required for subsequent learning (Gagné 1965 pp 20 21)

In the more general and long term sense cognitive structure variables refer to significant substantive and organizational properties of the learner s *total* knowledge in a given subject matter field that influence his future general academic performance in the same area of knowledge In the more specific and short term sense cognitive structure variables refer to the substantive and organizational properties of just the *immediately* or proximately relevant concepts and propositions within cognitive structure that affect the learning and retention of relatively small units of related new subject matter

For two kinds of cognitive structure variables Gagné (1965) makes a distinction between *lateral* and *vertical* transfer which is partly analogous to that (general and long term versus specific and short term) presented above In the first instance existing learning capabilities are applied somewhat indirectly and in a general sense to the solution of related problems or to the understanding of subject matter material in other disciplines This involves the generalizability of one set of existing learnings to the solution of tangentially related problems in a somewhat different area of knowledge This he says is lateral transfer Vertical transfer on the other hand applies to the situation where the mastery of a rather specific set of subordinate capabilities is prerequisite to the acquisition of higher-order capabilities within a rather limited sub area of knowledge

One obviously important variable affecting the learning and retention of new logically meaningful material is the *availability in cognitive structure of specifically relevant anchoring ideas* at a level of inclusiveness appropriate to provide optimal relatability and anchorage (derivative or correlative subsumption superordination) Now what happens if such specifically relevant ideas are not available in cognitive structure when new potentially meaningful material is presented to a learner? If some existing though not entirely or specifically relevant set of ideas cannot be utilized for assimilative purposes the only alternative is rote learning More typically however tangentially or less specifically relevant ideas are pressed into service The outcome is thus either a form of combinatorial assimilation or less relevant correlative subsumption In either case less efficient anchorage of the new material to cognitive structure occurs giving rise to relatively unstable or ambiguous meanings with little longevity The same outcome may also result when appropriately or specifically relevant subsumers *are* available if their relevance is not recognized For both reasons therefore in meaningful verbal learning situations it is preferable to introduce suitable organizers (introductory materials at a high level of generality and inclusiveness presented in advance of the learning material) whose relevance to the learning task is made explicit to serve an assimilative role rather than to rely on the spontaneous availability or use of appropriate anchoring ideas in cognitive structure.

If the new learning material (for example, the Darwinian theory of evolution) is entirely unfamiliar to the learner, the organizer might include whatever established and relevant knowledge presumably exists in his cognitive structure that would make Darwinian theory more plausible, cogent, or comprehensible. The organizer itself (a highly general and inclusive statement of Darwinian theory) would thus be learned by combinatorial assimilation, making explicit both its relatedness to generally relevant knowledge already present in cognitive structure and its own relevance for the more detailed aspects of or supportive evidence for Darwinian theory, and these latter detailed aspects (the learning task itself) would then be subsumed under the organizer (derivative and correlative subsumption). If the new learning material is not completely novel (for instance, later presentation of Lamarck's theory of evolution), the organizer might point out explicitly in what ways the two theories are similar and different. Thus whether already established anchoring ideas are nonspecifically or specifically relevant to the learning material, the organizer both makes this relevance more explicit, and is itself explicitly related to the more differentiated content of the learning task.

A second important factor presumably affecting the learning retention of a potentially meaningful learning task is the extent to which it is *discriminable* from the established ideational systems that assimilate it and vice versa. A reasonable assumption here, borne out by preliminary investigation, is that if the new ideas to be learned (for example, the tenets of Buddhism) are not clearly discriminable from established ideas in cognitive structure (in this case, the tenets of Christianity), the Buddhism meanings both manifest initially low dissociability strength and lose it rapidly because they can be adequately represented by the latter (the tenets of Christianity) for memorial purposes. For both reasons they would tend *not* to persist as dissociable entities in their own right. In other words, only discriminable categorical variants of more inclusive established meanings have long-term retention potentialities.

Lastly, the learning and longevity in memory of new meaningful material are functions of the *stability and clarity* of its anchoring ideas. If they are ambiguous and unstable, they not only provide inadequate relatability and weak anchorage for potentially meaningful new materials but also cannot be easily discriminated from them.

The influence of cognitive structure variables has thus far been investigated only in short-term studies in which the organizational properties of just the immediately or proximately relevant ideas within a particular subject-matter field were experimentally varied in order to ascertain the effects of such manipulation on the learning and retention of small units of related subject matter It is even more important, perhaps, to discover how significant organizational properties of the learner's *total* knowledge in a given discipline influences his future academic performance in the same area of knowledge In both kinds of research, programmed learning tech niques can be advantageously employed to vary particular cognitive struc ture variables while holding others constant

### *Cognitive Structure Variables versus Readiness*

Cognitive structure variables refer to the substantive and organizational properties of the learner s existing knowledge in a particular subject matter field Readiness," as the term is generally understood implies, on the other hand that his *developmental level* of cognitive functioning is such as to make a given learning task possible with reasonable economy of time and effort Thus, in contradistinction to cognitive structure variables, readiness, in the developmental sense of the term, is not determined by the existing *state* of the learner s subject matter knowledge in a given field, but rather by his *cognitive maturity* or *level of intellectual functioning* The latter factor will be considered in Chapter 5

In both instances we are actually dealing with a type of *readiness* for new learning But in one case the readiness is a function of previously acquired *subject matter knowledge,* that is of its organizational and sub stantive properties In the other case, it is a function of the *maturity of his cognitive capacities* irrespective of his *particular* subject matter background

### Learning and the Availability of Relevant Anchoring Ideas

Whether or not relevant anchoring ideas at an appropriate level of abstraction, generality, and inclusiveness are available in cognitive structure is an obviously important antecedent variable in meaningful learning and retention In this section we propose to review various short term studies of meaningful learning retention and problem solving in which this variable is implicated Where studies of infra human, nonverbal, or rote learning are particularly relevant, they are also included Studies such as these exemplify the transfer paradigm providing that the cognitive structure variable is manipulated during a preliminary or training period so that the effect of this manipulation on a *new* learning task can be ascertained For example, a study indicating that the overlearning of a given passage results in increased retention would *not* constitute relevant evidence—from the standpoint of transfer—about the influence of cognitive structure on reten tion, it would merely reflect the influence of amount of practice on retention, inasmuch as practice rather than altered cognitive structure is the only *measurable* independent variable that is relevant under these circumstances On the other hand, evidence that the overlearning of passage *A* by an experimental group (as compared to a control group which does not over learn passage *A*) leads to superior retention of related passage *B*, would be relevant evidence of the influence of cognitive structure on retention

## *Short Term Studies*

SPONTANEOUS ANTECEDENT ORGANIZATION Many different kinds of cog nitive functioning are facilitated by the spontaneous (uncontrived) presence and use of organizing concepts within cognitive structure E C Poulton (1957) showed that memory for short meaningful statements varies directly *with the subjects' degree of certainty regarding their truth,* which in turn reflects relative degree of subject matter sophistication in the area covered by the statements in question Thus the more background knowledge an individual has in a particular discipline, and the more stable this knowledge is, the more successful he is in learning related materials Memory for a body of items was also found to vary directly with the number of categories subjects were required to use in classifying the items (Mathews, 1954) Associative clustering in the recall of words is a somewhat more spontaneous manifestation of the same tendency to maximize rote retention by organizing discrete items around existing categorical subsumers The possibility of such clustering is obviously greater if the words themselves are relatively familiar (Bousfield, Cohen, and Whitemarsh, 1958) The facilitation of word sequence learning by grammatical structure (Osgood, 1953) is still another example of the influence of cumulatively learned antecedent organization on cognitive functioning Ability to learn unfamiliar word meanings in one s mother tongue from their use in context illustrates the application of a highly established general coding system to the solution of a specific problem (Bruner 1957, Marks and Miller, 1964, Schwartz and Lippman 1962)

MEDIATIONAL ORGANIZATION Various kinds of verbal pre training facil itate learning and problem solving by providing an organizing subsumer or general coding principle Reversal learning is facilitated when the first of two principles or discrimination problems is overlearned and thereby serves as a paradigm for the second problem (Bruner, 1957, Pubols, 1957, L. S Reed, 1953 Sassenrath, 1959) Bilateral transfer effects (Munn, 1932) *similarly depend on the* acquisition of a generally applicable pattern of neuromuscular co-ordinations at the disposal of any bodily member Verbal prefamiliarization with the content of films by means of a pretest (Stein, 1952) or by exposure to key words (Weiss and Fine, 1956), also facilitates learning and retention In concept formation, the facilitating effect of verbal pre training is relative to subjects' mastery of discriminative verbal cues during pre training (Rasmussen and Archer, 1961, Goss and Moylan 1958, Yarcozower, 1959) Discrimination pre training with the *same words* used in the criterion task proved superior in textual learning to no discrimination pre training whatsoever, or to discrimination pre training with the letters composing the words used in the criterion task (Staats, Staats, and Schutz, 1962)

The relevance of the antecedent elements of cognitive structure for the new learning material is also an important factor in cognitive functioning Concepts are more easily acquired if the specific instances from which they are abstracted are frequently rather than rarely associated with their defining (criterial) attributes and if subjects have more rather than less relevant information about the nature of this attribute (Underwood and Richardson, 1956) Relevant and meaningful antecedent context similarly facilitates the perception of connected verbal material when subthreshold tachistoscopic exposure times are used (Haselrud, 1959) P Saugstad (1955) has shown that the solution of problems, such as Maier s two pendulum problem, is largely dependent on the availability of relevant concepts

Evidence continues to accumulate regarding the mediating function of implicit verbal processes in concept formation[2] A A Liublinskaya (1957) H H Kendler and A D Karasik (1958), and J E Carey and A E Goss (1957) have demonstrated that the availability of distinctive verbal responses facilitates concept formation and conceptual transfer, and, confirming earlier findings in this area M W Weir and H W Stevenson (1959) reported that explicit instructions to verbalize enhances transposition learning in children and that this effect is unrelated to chronological age within the age range of 3 to 9 Mere ability to verbalize however, may constitute no advantage in simple transposition problems,[3] preverbal preschool children seem to do as well as 'verbal preschool children (Gonzalez and Ross 1958, Rudel 1958)

The interposition of a time delay between training and test problems enhances transposition behavior (Stevenson and Langford, 1957) presumably by de-emphasizing the importance of *absolute* differences and by making

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[2] The organizing function of Bartlett s schemata in the perceptual and reproductive phases of meaningful learning and retention has been considered elsewhere Goss (1961) offers an elaborate theoretical discussion of the acquisition of conceptual schemes and of their mediating and organizing uses

[3] These are problems in which the subject having learned a given relation ship (for instance to choose the larger of a pair of blocks) displays understanding of (transposes) this relationship to another pair of blocks of different absolute size

*relational* principles more salient Even when the transfer task requires reversal of the training principle further training on the original form of the principle accompanied by mediating symbolic processes has facilitating rather than inhibitory effects The use of verbal ( secondary ) cues (knowledge that each French noun has an initial la or le term) produces greater transfer to new instances of the class than does a primary cue [the French names of 12 common stimuli] or a tertiary cue (knowledge that la and le are articles) (Wittrock and Keislar 1965)

Recognition of the role of cognitive structure in symbolic learning—and even in rote and simple discrimination learning—is implicit in such neobehavioristic mediational hypotheses as those offered by C E Osgood (1953 1957) and O H Mowrer (1960) The formation of such mediating cognitive structures as response produced cues and covert verbal responses has been postulated to explain the facilitating influence of verbal pre training on concept formation (Carey and Goss 1957 Kendler and Karasik 1958) paired associate learning (Norcross and Spiker 1958) and reversal learning (Bensberg 1958 Kendler and D Amato 1955 Sassenrath 1959) A E Goss and M C Moylan (1958) and M Yarcozower (1959) have shown that this facilitating effect is relative to the extent to which subjects have mastered discriminative verbal cues during pre training

## THE EFFECT OF ADVANCE ORGANIZERS ON LEARNING AND RETENTION

L Postman s (1954) study of the effect of learned rules of organization on rote learning and retention is an interesting precursor of the use of advance organizers in the meaningful learning of connected verbal discourse This investigator found that explicit training in the derivation of figural patterns from code models facilitates the retention of the figural material that the relative effectiveness of such preliminary training increases with the retention interval and that the training reduces the susceptibility of the memory material to retroactive inhibition In essence then this experiment involved the facilitation of rote retention by meaningful rules of organization the learning task was relatively arbitrary verbatim and unrelatable to cognitive structure but each component was relatable to an explicitly learned code which in this instance was analogous to a subsuming principle J H Reynolds (1966) similarly demonstrated that an organized perceptual structure can facilitate rote verbal learning

In addition to their practical usefulness as a pedagogic device organizers can also be used to study programmatically the effects of cognitive structure variables By systematically manipulating the properties of organizers it is possible to influence various attributes of cognitive structure (the availability to the learner of relevant and proximately inclusive subsumers the clarity stability discriminability cohesiveness and integrativeness of these subsumers) and then to ascertain the influence of this manipulation on new learning, retention, and problem solving Such studies follow the transfer paradigm providing that they employ control subjects who are exposed to similar but non-organizing introductory materials

The use of expository organizers to facilitate the learning and retention of meaningful verbal learning is based on the premise that logically meaningful material becomes incorporated most readily and stably in cognitive structure insofar as it is subsumable under specifically relevant existing ideas It follows, therefore, that increasing the availability in cognitive structure of specifically relevant subsumers—by implanting suitable organizers—should enhance the meaningful learning of such material Research evidence (Ausubel, 1960, Ausubel and Fitzgerald, 1961, 1962, Ausubel and Youssef 1963, Merrill and Stolurow, 1966, Newton and Hickey, 1965), in fact, confirms this supposition The facilitating effect of purely expository organizers, however, typically seems to be limited to learners who have low verbal (Ausubel and Fitzgerald, 1962) and analytic (Schulz, 1966) ability, and hence presumably less ability to develop an adequate scheme of their own for organizing new material in relation to existing cognitive structure [4] And the same availability of a relevant superordinate proposition in cognitive structure also enhances meaningful retention by decreasing the rate at which the original dissociability strength of the material declines (by decelerating the rate of obliterative assimilation) (Ausubel and Fitzgerald, 1961)

Advance organizers probably facilitate the incorporability and longevity of meaningfully learned material in three different ways First they explicitly draw upon and mobilize whatever relevant anchoring concepts are already established in the learner s cognitive structure and make them part of the subsuming entity Thus not only is the new material rendered more familiar and potentially meaningful but the most relevant ideational antecedents in cognitive structure are also selected and utilized in integrated fashion Second advance organizers at an appropriate level of inclusiveness by making subsumption under specifically relevant propositions possible (and drawing on other advantages of subsumptive learning) provide optimal anchorage This promotes both initial learning and later resistance to obliterative subsumption Third the use of advance organizers renders unnecessary much of the rote memorization to which students often resort because they are required to learn the details of an unfamiliar discipline before having available a sufficient number of key anchoring ideas Because

[4] When the learning task is particularly difficult however organizers may differentially benefit high ability students (Grotelueschen 1967) and those with more background knowledge (Ausubel and Fitzgerald 1962) by making it possible for them to learn material that would in any case be beyond the capacity of less able and less sophisticated students

of the unavailability of such ideas in cognitive structure to which the details can be nonarbitrarily and substantively related the material, although logically meaningful, lacks potential meaningfulness

TRANSFER OF GENERAL PRINCIPLES IN PROBLEM SOLVING Much positive transfer in problem solving and other kinds of learning is attributable to the carryover of general elements of strategy, orientation and adaptation to the problem Systematic instruction in approach to a given task has been shown to facilitate both motor learning (Duncan, 1953) and memorization (Woodrow, 1927) Overlearning of the training task tends to reduce negative transfer in serial rote learning (Atwater, 1953, Bruce, 1933, Mandler, 1954, Underwood 1949, Yarcozower, 1959) because it establishes the particular relevance of specific elements for specific instances, while at the same time permitting the positive transfer of general factors The same basic phenomenon can also be observed in rat maze learning (T A Jackson 1932 Wiltbank, 1919)

More explicit facilitation of the learning of skills by deliberately making a transferable general principle (the nature of refraction) available, is seen in C H Judd s classical experiment on learning how to shoot submerged targets (Hendrickson and Schroeder, 1941, Judd, 1902, Overing and Travers 1966) Prior learning of principles similarly enhances problem solving ability in mathematics (Scandura 1966a b) S M Ervin (1960c) also found that verbal instruction in the relevant physical principles underlying a given motor performance increases transfer to an analogous motor performance However this effect does not occur unless subjects are able to perceive both the similarity between the two motor tasks and the link between verbal principles and performance In solving puzzle type problems both G Katona (1940) and E R. Hilgard and his co-workers (1953 1954) have demonstrated that understanding of a general principle is more transferable to a given class of problems than is rote memorization of the solution R S French (1954) obtained similar findings in a study which required subjects to learn sequentially dependent concepts

TRANSFER AND LEARNING SET The learning set phenomenon, learning to learn successive transfer, or progressive intra problem improvement in performance (Harlow, 1949, Keppel and Postman 1966) also illustrates the gradual acquisition of a general coding principle which facilitates the solution of a given class of problems Both C P Duncan (1953) and L. Morrisett and C I Hovland (1959) have demonstrated that transfer in learning set problems is a function of mastery (practice) within a given type of problem as well as of experience with a large number of specific variants of this problem type These experiments therefore further substantiate the value of overlearning and multicontextual experience in learning generic coding systems

Many complex learning tasks particularly those which are sequential in nature can be analyzed into a hierarchy of component learning sets or units R M Gagné and N E Paradise (1961) define the latter as a set of subordinate capabilities consisting of knowledge relevant to any given final task to be learned The rate of learning these units and the extent to which they can be recalled are more highly related to final achievement on the learning task than are general learning ability or previous mathe matics grades (Gagné and Paradise 1961 Gagné Mayor Gartens and Para dise 1962) Serious breakdowns in learning can often be attributed to inad vertent omission of a logically essential component unit from the total task or to its inadequate integration with other components

### *Long Term Studies*

Despite their self evident significance for school learning long term studies of cognitive structure variables involving subject matter achievement are extremely sparse Very little research in this area conforms to the mini mally necessary research design (the transfer paradigm) which requires that a single attribute of cognitive structure first be deliberately manipulated using adequate experimental and/or statistical control procedures and that this altered cognitive structure then be related to long term achievement outcomes in an extended program of *new* studies in the same field

INFLUENCE OF EXISTING DEGREE OF KNOWLEDGE ON ACADEMIC ACHIEVE MENT Studies in which degree of existing knowledge of subject matter at one level of educational attainment is related to performance at subsequent educational levels conform to the long term transfer paradigm Constancy of academic attainment is of course partly attributable to constancy of academic aptitude and motivation But especially when these latter factors are controlled it is reasonable to attribute some of the obtained relation ship between earlier and later educational levels to the cumulative effects of cognitive structure variables (Garside 1957 C H Swenson 1957) C H Swenson for example reported that holding academic aptitude constant students from the upper two fifths of their graduating classes make signif icantly higher quality point averages in college courses than do students from the lower three fifths [5] But T L Engle (1957) found that university grades in psychology for students who had psychology in high school were no higher than the grades of students who did not have psychology in high school This lack of relationship reflected in part significant differences in content and emphasis between high school and college psychology courses

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[5] Similar findings were reported by Sommerfield and Tracy (1961) using Algebra I grades as a predictor for success in Algebra II in high school

From the standpoint of rational principles of curriculum development, however, introductory courses in a given field of knowledge might normally be expected to establish the type of cognitive structure that would facilitate the later assimilation of more advanced and highly differentiated material in the same field

IMPROVEMENT OF INSTRUCTION Many of the curriculum reform movements attempt to enhance long term learning and retention by influencing cognitive structure variables The University of Illinois Committee on School Mathematics (Beberman, 1958) for example, stresses initial self discovery of generalizations by students, followed by precise, consistent, and unambiguous verbalization of modern concepts The Secondary School Physics Program of the Physical Science Study Committee (Finlay, 1959) places great emphasis on the more integrative and widely generalizable concepts in modern physics, on inquiry in depth rather than on broad, superficial coverage of the field, on careful, sequential programming of principles, and on conveying to the student something of the spirit and methods of physics as a developing experimental science Implicit in each program is the assumption that whatever ultimate superiority in academic attainment is achieved by following these pedagogic principles is attributable to cumulative changes in the organizational and substantive properties of cognitive structure

Achievement test data provided by evaluative studies of such programs offer presumptive evidence regarding the long term effects of cognitive structure variables Nevertheless this type of research does not adequately conform to our transfer paradigm since the learning of *new* material or later academic performance in the same subject matter field is not studied as a function of earlier substantive or organizational changes in cognitive structure that can be plausibly attributed to *specifiable* characteristics of the curriculum, it tells us only that *cumulative* achievement at some designated point in time is presumably superior because of the *cumulative* effects of the program Furthermore not only is it impossible in such programs to isolate the effects of the individual independent variables involved, but also only rarely is any effort made to obtain comparable achievement data from control groups or to control for the Hawthorne effect [6] Measurement is also a difficult problem because standardized achievement tests cover various traditional subject matter units deliberately ignored by these new curricula,

[6] The Hawthorne effect refers to the improvement in criterial task performance induced by some novel but superficial aspects of the treatment given the experimental group (or simply by the fact that this group is singled out for special treatment) rather than by the postulated experimental variable It can be avoided by using a control group that is given an overtly similar but intrinsically different treatment than that given to the experimental group

as well as fail to measure knowledge of the more modern content which the latter emphasize All of these difficulties point up the unfeasibility of using curriculum-development research as a source of rigorous experimental evidence bearing on a *single* cognitive structure variable

IMPROVEMENT OF THINKING Promising attempts to enhance critical thinking ability by influencing cognitive structure in particular subject matter areas have been made by M L Abercrombie (1960) J R Suchman (1959 1960) and B O Smith (1960) Abercrombie tried to improve medical students ability to reason more effectively by providing them with opportunities for therapeutic group discussion in an unstructured nonauthoritarian atmosphere Analysis of X rays was used as the criterion measure for assessing the effects of this training Abercrombie s findings were generally in the predicted direction but are vulnerable on the grounds of failure to control for the so-called Hawthorne effect

Suchman (1960) has been experimenting with the teaching of strategies and tactics of scientific inquiry to children who learn to apply them in question and answer investigations Preliminary findings (1959) indicate that although such training increases the number of valid questions children ask in the test (criterion) situation it does not significantly enhance the quality of the questions or facilitate grasp of concepts Hence more definitive evidence of the transfer value of such training to new situations is being sought and the new criteria of transfer being employed are not only more independent of the particular training procedures used but are also more reflective of the ultimate purpose of such training greater knowledge of the content and/or the method of science

B O Smith and Henderson developed instructional materials designed to develop critical thinking abilities and helped the teachers learn how to handle these materials in the classroom [They] found wide differences among teachers with respect to improvement of their students in critical thinking (B O Smith 1960) but refrained from drawing definitive conclusions because they had not as yet devised a technique for describing and measuring what teachers were *actually* doing in this situation Their next step therefore was to devise a method of categorizing the logical operations involved in teaching The great promise of this approach is twofold First the attempt to influence critical thinking is based on the simultaneous teaching of the logic of a particular subject matter field along with its content rather than on instruction in *general* principles of logic Second by quantifying crucially important but elusive teaching variables this category system can do much to place long term classroom studies of cognitive structure variables on a sound experimental basis M J Aschner (1961) has developed another useful category system for clarifying thought processes that are reflected in verbal behavior [based] on Guilford s conception of the structure of intellect

AUTOMATED TEACHING Similar kinds of presumptive evidence regarding the long term effects of cognitive structure variables come from studies of automated teaching S L Pressey (1960) systematically used a self instructional (punchboard) device as an integral part of a course in educational psychology This device both provides immediate feedback and guides the student to the correct answer if he is wrong Students using the punchboard make higher midterm and final examination scores than do students in the control group J K Little (1960) and A L Stephens (1960) reported similar findings

Long term experimental evidence derived from more modern teaching machine procedures is equally sparse but generally substantiates the conclusion that such procedures are approximately as effective as conventional teaching methods The study conducted by B F Skinner and J G Holland (1960) on the effectiveness of programmed instruction in introductory psychology for example is subject to the methodological criticism that control groups were not used Better-controlled studies in the same subject matter area (W F Oakes 1960 Ter Keurst 1965) give conflicting findings D Porter s (1959) research on programmed instruction in spelling (1959) and S R Meyer s (1960b) vocabulary study are notable for the use of matched control groups and demonstrate a consistent advantage in favor of the automated techniques A well controlled experiment on the automated teaching of fourth grade arithmetic suggests no superiority for this approach except in the case of low IQ pupils (Joos 1961) But despite the paucity of rigorous experimental work in this area it is evident that with proper controls manipulation of single variables and the use of the transfer paradigm automatic teaching devices could provide much valuable evidence on the long term effect of cognitive structure variables

## The Role of Discriminability in Meaningful Learning and Retention

The discriminability of new learning material from previously learned concepts in cognitive structure is a major variable in meaningful learning and retention In the effort to simplify the task of apprehending the environment and representing it in cognitive structure new learning material that resembles existing knowledge often tends to be interpreted as identical to the latter despite the fact that objective identity does not exist Existing knowledge in other words tends to preempt the cognitive field and to superimpose itself on similar potential meanings Under these circumstances the resulting meanings obviously cannot conform to the objective content of the learning material In other instances the learner may be cognizant of the fact that new propositions differ somehow from established principles in cognitive structure, but is unable to specify wherein the difference lies When this situation exists ambiguous meanings emerge permeated by doubt confusion and alternative or competing meanings In either case however the newly learned meanings enjoy relatively little initial dissociability strength In addition if new meanings cannot be readily distinguished from established meanings they can certainly be adequately represented by them for memorial purposes and thus tend to lose their initial dissociability strength or become reduced more rapidly, than initially discriminable meanings This is especially true for longer retention periods Over short retention intervals nondiscriminable material can be retained on a purely rote basis

Lack of discriminability between new ideas and previously learned propositions in cognitive structure may account for some negative transfer (proactive interference) in school learning This is particularly the case when the two sets of ideas are confusably similar and when the previously learned ideas are neither clear nor well established Under these conditions the learner may possibly encounter greater difficulty in learning the new ideas than if he had not been previously exposed to a confusably similar set of propositions P Suppes and R Ginsberg (1963) for example found evidence of negative transfer when first graders learned the concept of identity of ordered sets after previously learning the concept of identity of unordered sets

The discriminability of a new learning task is in large measure a function of the clarity and stability of the existing ideas to which it is relatable in the learner s cognitive structure In learning an unfamiliar passage about Buddhism for example subjects with greater knowledge of Christianity make significantly higher scores on the Buddhism test than do subjects with less knowledge of Christianity (Ausubel and Blake 1958 Ausubel and Fitzgerald 1961 Ausubel and Youssef 1963) This significantly positive relationship between Christianity and Buddhism test scores holds up even when the effect of verbal ability is statistically controlled (Ausubel and Fitzgerald 1961) When a parallelly organized passage about Zen Buddhism is introduced after the Buddhism passage superior knowledge of the latter similarly facilitates the learning of the Zen Buddhism material when verbal ability is held constant (Ausubel and Youssef 1963) Thus much of the effect of overlearning—both on retaining a given unit of material and on learning related new material—is probably a reflection of the enhanced discriminability it induces and this effect can be accomplished by overlearning either the learning material itself or its anchoring ideas

When discriminability between new learning material and established ideas in cognitive structure is inadequate because of the instability or ambiguity of prior knowledge comparative organizers that explicitly delineate similarities and differences between the two sets of ideas can significantly increase discriminability and hence facilitate learning and retention (Ausubel and Fitzgerald 1961) This method of facilitating learning and retention is probably more effective than overlearning of the new material since such overlearning does not in any way strengthen or clarify the established concepts which provide anchorage for long term retention When established ideas in cognitive structure are *already* clear and stable however organizers do not have a facilitating effect (Ausubel and Fitzgerald 1961) Under these latter circumstances overlearning of the new material is the only feasible way of further enhancing discriminability In conceptual learning presenting sequences of stimuli that provide successive contrasts between relevant and irrelevant criterial attributes tends to facilitate concept formation (Detambel and Stolurow 1956)

Attempts to increase the discriminability of verbal learning materials through techniques other than overlearning of new material or the use of advance organizers have not been strikingly successful Merely establishing a set to perceive differences between two related passages does not in and of itself enhance retention although the learning and retention of *differences* alone is enhanced by the use of explicit directions to notice the differences (Wittrock 1963a) and the inclusion of explicit comparisons within the learning passage itself produces somewhat equivocal results (Ausubel and Blake 1958)

For several plausible reasons advance comparative organizers are more effective than intra material comparisons In the first place they provide advance ideational scaffolding Second they provide the learner with a generalized overview of *all* of the major similarities and differences between the two bodies of ideas before he encounters the new concepts individually in more detailed and particularized form Finally they create an advance set in the learner to perceive similarities and differences and by avoiding overly explicit specification encourage him *actively* to make his own differentiations in terms of his own particular sources of confusion (Ausubel and Fitzgerald 1961) M C Wittrock (1963b) for example showed that part of the facilitating effect of a comparative organizer on learning and retention is attributable to the effects of a learning set He demonstrated that merely a set to contrast or to compare and contrast Buddhism with Christianity in the absence of a comparative organizer enhances the immediate and delayed Buddhism retention scores of undergraduate students

Sometimes in meaningful learning and retention new learning material may be adequately discriminable from existing ideas in cognitive structure but may be in real or seeming contradiction to these ideas When this happens the learner may peremptorily dismiss the new propositions as invalid may try to set them apart from previously learned knowledge (retain them on a rote basis) or hopefully may try to reconcile and integrate the two sets of ideas in relation to a more inclusive subsumer The function of an advance organizer in this type of learning situation would be to provide just such a subsumer

## Stability and Clarity of Anchoring Ideas

Little reliable evidence is available regarding the effect of overlearning on the relative stability of anchoring ideas in cognitive structure, and hence on their relative ability to enhance meaningful verbal learning and retention D Ausubel and D Fitzgerald (1962) found that degree of knowledge of antecedent learning material is positively related to the learning of a sequentially *dependent* passage, but the number of times that the first passage is read bears no relationship to the learning of an *otherwise* sequentially *dependent* passage if the latter includes all of the essential points of the first passage as introductory material (Ausubel and Youssef 1966) In other words the positive transfer effect that increased stability of previously learned material has on the later *learning* of sequentially dependent material is no longer demonstrable if the essential elements of the antecedent material (the elements that make for the sequential dependence) are incorporated as introductory aspects of the second task This, of course, does not imply that the stability of antecedent material in cognitive structure has no positive transfer effect on the *long term retention* of otherwise sequentially dependent material when a summary of the antecedent material is included in the second task Thus the two procedures—overlearning the antecedent material and incorporating a summary of it into the second task—are by no means mutually preclusive and can be used to complement each other in learning sequentially organized material The previously cited work of R M Gagne and N E Paradise (1961) and Gagné, J R Mayor H Garstens and N E Paradise (1962) is also relevant in this connection

Presentation of heterogeneous stimulus material that does not provide sufficient repetition to allow for mastery is not only less effective than homogeneous presentation in learning a principle, but also does not facilitate the learning of a reversal principle during the transfer period (Sassenrath 1959) Reversal learning in rats and nursery school children is similarly facilitated when the first of two discrimination problems is overlearned (Bruner, Mandler, O Dowd and Wallach 1958, March, 1964, Pubols 1957, L S Reed 1953) According to J S Bruner learning often cannot be translated into a generic form until there has been enough mastery of the specifics of the situation to permit the discovery of lower-order regularities which can then be recombined into higher-order more generic coding systems (Bruner, 1957, p 60) In serial and paired associate rote learning under conditions comparable to stimulus generalization increased practice on the training task tends to increase positive transfer (Bruce, 1933, Bruner, 1961), and under conditions typically associated with negative transfer, increased prior training tends to reduce and even reverse the direction of negative transfer (Atwater, 1953 Mandler, 1954, Siipola 1933, Underwood, 1949, Young and Underwood, 1954)

Reference has already been made to short term research evidence on the relationship between existing degree of knowledge and the learning of unfamiliar material in the same subject matter field Students with a more extensive knowledge of Christianity are better able to learn principles of Buddhism than are students of equal academic aptitude who have less knowledge of Christianity (Ausubel and Fitzgerald, 1961) Similarly, subjects who have more *general* background knowledge in endocrinology learn and retain more unfamiliar material about the endocrinology of pubescence than do a matched control group with less general background knowledge of endocrinology (Ausubel and Fitzgerald, 1962) In the first instance, where the new learning material (Buddhism) is specifically relatable to existing knowledge (Christianity) the facilitating effect of increased knowledge about Christianity can be attributed both to the availability of more specifically relevant anchoring ideas and to greater discriminability between the two sets of analogous ideas In the second instance, where the new learning material (endocrinology of pubescence) is not *specifically* relatable to previously learned principles, general background knowledge in endocrinology probably facilitates learning and retention both by providing at least a non specific background basis for relating the new material to cognitive structure (combinatorial learning), and by increasing the familiarity of the pubescence material (and hence the learner s confidence in coping with it) The background knowledge here also seems to enhance the effect of an organizer

Perhaps the most important feature of automated teaching devices, insofar as the facilitation of meaningful learning and retention is concerned, is not the incentive and drive reducing effects of immediate feedback,[7] but the extent to which these devices influence learning by enhancing the stability and clarity of cognitive structure By deferring the introduction of new material until prior material in the learning sequence is consolidated they maximize the effect of stability of cognitive structure on new learning and by supplying immediate feedback, these devices rule out and correct alternative wrong meanings, misinterpretations, ambiguities and miscon

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[7] The reinforcement value of feedback as conceived by B F Skinner is discounted by the fact that subjects who make no spontaneous overt response which can be reinforced (who respond covertly or merely read the correct response) generally learn and retain programmed verbal material just as well as subjects who independently and overtly construct their own responses (Della Piana 1961 Evans, Glaser Homme 1960a Krumboltz 1961)

ceptions before they have an opportunity to impair the clarity of cognitive structure and thereby inhibit the learning of new material Because of the rigor with which such variables as degree of consolidation and amount and immediacy of feedback can be controlled programmed instruction can be very useful in studying the effects of the stability and clarity of cognitive structure on sequential learning

Many investigators as a matter of fact have used automated teaching devices in short term studies of learning and retention but have generally restricted their attention to the relative effectiveness of these devices as compared to conventional classroom instruction It has been reported for example that university students using simulated teaching machines (Coulson and Silberman 1960b) and programmed textbooks (Evans Glaser and Homme 1960b) are better able to learn small units of meaningful material than are control groups employing comparable conventional methods These studies also isolated the effects of such variables as size of step and mode and overtness of response But until the transfer paradigm is followed (that is until the effect of prior exposure to such factors is related to the learning of *new* material) the rich potentialities of these devices for increasing our knowledge of cognitive structure variables will not be realized

## Pedagogic Facilitation of Transfer

What are some of the pedagogic implications both of the foregoing model of the psychological structure of knowledge and of the factors that influence its accretion and organization? The major implication for teaching perhaps is that inasmuch as existing cognitive structure reflects the outcome of *all* previous meaningful learning control over the accuracy clarity longevity in memory and transferability of a given body of knowledge can be most effectively exercised by attempting to influence the crucial variables of cognitive structure This is particularly important in view of the geometrical increase in new knowledge

In principle deliberate manipulation of the relevant attributes of cognitive structure for pedagogic purposes should not meet with undue difficulty As pointed out above it can be accomplished (a) *substantively* by using for organizational and integrative purposes those unifying concepts and propositions in a given discipline that have the widest explanatory power inclusiveness generalizability and relatability to the subject matter content of that discipline and (b) *programmatically* by employing suitable programmatic principles of ordering the sequence of subject matter constructing its internal logic and organization and arranging practice trials Hence transfer in school learning consists primarily of so shaping the learner s cognitive structure by manipulating the content and arrangement of his antecedent learning experiences in a particular subject matter area, *that* subsequent learning experiences are maximally facilitated

*The Use of Organizers*

The principal strategy advocated in this book for deliberately manipulating cognitive structure so as to enhance proactive facilitation or to minimize proactive inhibition involves the use of appropriately relevant and inclusive introductory materials (organizers) that are maximally clear and stable These organizers are introduced in advance of the learning material itself and are also presented at a higher level of abstraction, generality, and inclusiveness and since the substantive content of a given organizer or series of organizers is selected on the basis of their appropriateness for explaining integrating and interrelating the material they precede this strategy simultaneously satisfies the substantive as well as the programming criteria specified above for enhancing the organizational strength of cognitive structure Summaries and overviews on the other hand, are ordinarily presented at the same level of abstraction, generality, and inclusiveness as the learning material itself They simply emphasize the salient points of the material by omitting less important information and largely achieve their effect by *repetition and simplification*

As pointed out earlier the rationale for using organizers is based primarily on (a) the importance of having relevant and otherwise appropriate established ideas *already* available in cognitive structure to make logically meaningful new ideas potentially meaningful and to give them stable anchorage, (b) the advantages of using the more general and inclusive ideas of a discipline as the anchoring ideas or subsumers (namely the aptness and *specificity of their relevance their greater inherent stability, their greater* explanatory power and their integrative capacity), and (c) the fact that they themselves attempt both to identify already existing relevant content in cognitive structure (and to be explicitly related to it) and to indicate explicitly both the relevance of the latter content and their own relevance for the new learning material In short, *the principal function of the organizer is to bridge the gap between what the learner already knows and what he needs to know before he can successfully learn the task at hand*

The function of the organizer is to provide ideational scaffolding for the stable incorporation and retention of the more detailed and differentiated material that follows in the learning passage, as well as to increase discriminability between the latter material and similar or ostensibly conflicting ideas in cognitive structure In the case of completely unfamiliar material an expository organizer is used to provide relevant proximate subsumers These subsumers which bear a *superordinate relationship to* the new learning material, primarily furnish ideational anchorage in terms that are already familiar to the learner In the case of relatively familiar learning material, a "comparative' organizer is used both to integrate new ideas with basically similar concepts in cognitive structure, as well as to increase discriminability between new and existing ideas which are essentially different but confusably similar

The advantage of deliberately constructing a special organizer for each new unit of material is that only in this way can the learner enjoy the advantages of a subsumer which both (a) gives him a general overview of the more detailed material in *advance* of his actual confrontation with it, and (b) also provides organizing elements that are inclusive of and take into account most relevantly and efficiently the *particular content* contained in this material Any existing subsumer in the learner's cognitive structure which he could independently employ for this purpose typically lacks *particularized* relevance and inclusiveness for the new material and would hardly be available in advance of initial contact with it And although students might possibly be able to improvise a suitable subsumer for future learning efforts *after* they become familiar with the material, it is unlikely that they would be able to do so as efficiently as a person sophisticated in both subject matter content and pedagogy

Organizers also undoubtedly facilitate the learning of factual material more than they do the learning of abstract material, since abstractions, in a sense, contain their own built in organizers—both for themselves and for related detailed items D S Northrop (1952) showed that internal structuring enhances the learning of factual films, but actually inhibits the learning of ideational films It would, therefore, seem advisable to restrict the use of organizers to the learning of material that embraces a substantial body of differentiated or factual content, and hence offers adequate scope for the ideational scaffolding provided by abstract organizers

The pedagogic value of advance organizers obviously depends, in part, upon how well organized the learning material itself is If it already contains built in organizers and proceeds from regions of lesser to greater differentiation (higher to lower inclusiveness) rather than in the manner of the typical textbook or lecture presentation, much of the potential benefit derivable from advance organizers will not be actualized Regardless of how well organized learning material is however, it seems reasonable to expect that learning and retention can still be facilitated by the use of advance organizers at an appropriate level of inclusiveness Such organizers are available from the very beginning of the learning task, and their integrative properties are also much more salient than when introduced concurrently with the learning material To be useful however, organizers themselves must obviously be learnable and must be stated in familiar terms

### *Substantive Factors Influencing Cognitive Structure*

The task of identifying the particular organizing and explanatory principles in the various disciplines that manifest widest generality and integrative properties is obviously a formidable and long range problem However, experience with various curriculum reform movements indicates that it yields to sustained and resourceful inquiry, especially when it is possible to enlist the cooperative efforts of outstanding subject matter specialists talented teachers, and imaginative educational psychologists "Correct and illuminating explanations are no more difficult and are often easier to grasp than ones that are partly correct and, therefore, too complicated and too restricted Making material interesting is in no way incompatible with presenting it soundly, indeed a correct general explanation is often the most interesting of all' (Bruner, 1960, p 23)

The substantive objectives underlying the choice of subject matter content in the Physical Science Study Committee Secondary School Physics Program are relevant for most disciplines '(1) to plan a course of study in which the major developments of physics up to the present time are presented in a logical and integrated whole, (2) to present physics as an intellectual pursuit which is part of present-day human activity and achievement' (Finlay, 1959, p 574) The primary problem in implementing these objectives is

> how to construct curricula that can be taught by ordinary teachers to ordinary students and that at the same time reflect clearly the basic or underlying principles of various fields of inquiry The problem is two-fold first, how to have the basic subjects rewritten and their teaching materials revamped in such a way that the pervading and powerful ideas and attitudes relating to them are given a central role second how to match the levels of these materials to the capacities of students of different abilities at different grades in school (Bruner 1960 p 18)

The rationale of the Physical Science Study Committee for its particular choice of subject matter is clearly defensible in terms of providing a stable and widely transferable basis for the assimilation and integration of knowledge

> The Committee has chosen to select subject matter and organize it with the intent of providing as broad and powerful a base as possible for further learning —further learning both in and beyond the classroom Through its materials the Committee seeks to convey those aspects of science which have the deepest meaning the widest applicability
>
> The explanatory systems of physics and how they are made have much more forward thrust as educational tools than the individual application and the discrete, unconnected explanation Thus the PSSC has chosen for its subject matter the big over arching ideas of physics—those that contribute most to the contemporary

physicist s views of the nature of the physical world The power of the big ideas is in their wide applicability and in the unity they bring to an understanding of what may appear superficially to be unrelated phenomena Pedagogically this choice has virtues Principal among them is the acquisition of criteria by which subject matter can be selected and organized toward the coherence the sub ject itself strives for (Finlay 1960)

According to J S Bruner

optimal structure refers to the set of propositions from which a larger body of knowledge can be generated and it is characteristic that the formulation of such structure depends upon the state of advance in a particular field of knowledge Since the goodness of a structure depends upon its power for simplifying informa tion for generating new propositions and for increasing the manipulability of a body of knowledge structure must always be related to the status and gifts of the learner Viewed in this way the optimal structure of a body of knowledge is not absolute but relative The major requirement is that no two sets of generating structures for the same field of knowledge be in contradiction (Bruner, 1964b pp 308-309)

Appropriate structure of course, takes into account the developmental level of the pupil s cognitive functioning and his degree of subject matter sophistication Structure that is too elaborate in these terms constitutes more of a handicap than a facilitating device (S E Newman, 1957, Munro, 1959, Binter, 1963) Similarly structure that is appropriate for the teacher is not always appropriate for the pupil Premature acquisition of inappropriate structures may result in closure that inhibits the acquisition of more appropriate structures (Smedslund 1961)

The great expansion in knowledge that is currently taking place de mands special care in the selection of the big ideas As S C Ericksen puts it

teachers at all levels must begin to take more active measures to reduce the curricular lag between what is nice to know in contrast to what the present stu dent generation needs to know The slow to-change teacher might unknowingly actually hinder the student s educational efforts to protect himself from informa tional obsolescence From the Medical School faculty for example I have heard expressions like Half of what we teach will be outdated ten years from now and half of what the physician will need to know in ten years has not yet been dis covered (Ericksen 1967 pp 145-146)

Coordination and integration of subject matter at the different grade levels will also become more important

As the high school comes closer to doing the job professors imagine for it professors will be forced to imagine an appropriate new job for the college If so we must first learn that the American educational system is sequential that changes in one level of education requires changes in others that the task is shared by all teachers in all schools We shall find ourselves engaged in re-examination and revision of our own programs undergraduate and graduate Starting late the university must as usual scramble to catch up to keep up and finally to get far enough ahead to exercise its function of leadership by example as well as by precept (Diekhoff 1964 p 188)

Once the substantive organizational problem (identifying the basic organizing concepts in a given discipline) is solved, attention can be directed to the programmatic organizational problems involved in the presentation and sequential arrangement of component units Here it is hypothesized, various principles concerned with the efficient programming of content are applicable irrespective of the subject matter field These principles naturally include and reflect the influence of the previously listed cognitive structure variables—the availability of a relevant anchoring idea its stability and clarity, and its discriminability from the learning material

### *Progressive Differentiation*

When subject matter is programmed in accordance with the principles of progressive differentiation the most general and inclusive ideas of the discipline are presented first and are then progressively differentiated in terms of detail and specificity This order of presentation presumably corresponds to the natural sequence of acquiring cognitive awareness and sophistication when human being are spontaneously exposed either to an entirely unfamiliar field of knowledge or to an unfamiliar branch of a familiar body of knowledge It also corresponds to the postulated way in which this knowledge is represented organized and stored in the human cognitive system The two assumptions we are making here, in other words are that (a) It is less difficult for human beings to grasp the differentiated aspects of a previously learned more inclusive whole than to formulate the inclusive whole from its previously learned differentiated parts[8] and (b) An individual s organization of the content of a particular subject matter discipline in his own mind consists of a hierarchical structure in which the most inclusive ideas occupy a position at the apex of the structure and subsume progressively less inclusive and more highly differentiated propositions concepts and factual data

[8] This proposition simply restates the principle that subsumptive learning is easier than superordinate learning The argument for using organizers rests on the same principle It is appreciated however that the learning of certain propositions requires the synthesis of previously acquired subordinate concepts or propositions (superordinate learning) (Gagné 1962) The need for periodic superordinate learnings however does not negate the proposition that both the psychological organization of knowledge and the optimal organization of subject matter *generally* exemplify the principle of progressive differentiation

Now if the human nervous system as a data processing and storing mechanism is so constructed that both the acquisition of new knowledge and its organization in cognitive structure conform *naturally* to the principle of progressive differentiation, it seems reasonable to suppose that optimal learning and retention occur when teachers deliberately order the organization and sequential arrangement of subject matter along similar lines. A more explicit way of stating the same proposition is to say that new ideas and information are learned and retained most efficiently when more inclusive and specifically relevant ideas are already available in cognitive structure to serve a subsuming role or to furnish ideational anchorage. Organizers, of course, exemplify the principle of progressive differentiation and serve this function in relation to any given topic or subtopic where they are used. In addition, however, it is desirable that both the arrangement of the learning material itself, within each topic or subtopic and the sequencing of the various subtopics and topics in a given course of study also generally conform to the same principle.

But even though this principle seems rather self-evident it is rarely followed in actual teaching procedures or in the organization of most textbooks. The more typical practice is to segregate topically homogeneous materials into separate chapters and subchapters, and to order the arrangement of topics and subtopics (and the material within each) solely on the basis of topical relatedness without regard to their relative level of abstraction, generality, and inclusiveness. This practice is both incompatible with the actual structure of most disciplines and incongruous with the postulated process whereby meaningful learning occurs, with the hierarchical organization of cognitive structure in terms of progressive gradations of inclusiveness, and with the mechanism of accretion through a process of progressive differentiation of an undifferentiated field. Thus, in most instances, students are required to learn the details of new and unfamiliar disciplines before they have acquired an adequate body of relevant subsumers at an appropriate level of inclusiveness (Ausubel, 1960).

As a result of this latter practice, students and teachers are coerced into treating potentially meaningful materials as if they were rote in character and consequently experience unnecessary difficulty and little success in both learning and retention. The teaching of mathematics and science, for example, still relies heavily on rote learning of formulas and procedural steps, on rote recognition of stereotyped "type problems," and on mechanical manipulation of symbols. In the absence of clear and stable ideas which can serve as anchoring points and organizing foci for the incorporation of new logically meaningful material, students are trapped in a morass of confusion and have little choice but rotely to memorize learning tasks for examination purposes.

One outstanding example of a textbook which is organized in accor dance with the principle of progressive differentiation is W Boyd s (1961) famous *Textbook of Pathology* In this book Boyd parts company with most traditional treatises on pathology which typically consist of about twenty chapters each devoted to describing serially the major kinds of pathological processes occurring within a particular organ or organ system Boyd in contrast reserves serial consideration of the pathology of separate organ systems to the second half of his text and devotes the entire first half to such general organizing and integrative topics as the different categories of pathological process (inflammation allergy degeneration neoplasm) and their principal causes and characteristics the various kinds of etiological agents in disease types of humoral and tissue resistance to disease the inter action between genic and environmental factors in the development of pathological processes and general relationships between pathological lesions and clinical symptoms

Progressive differentiation in the programming of subject matter is accomplished by using a hierarchical series of organizers (in descending order of inclusiveness) each organizer preceding its corresponding unit of detailed differentiated material and by sequencing the material within each unit in descending order of inclusiveness In this way not only is an appropriately relevant and inclusive subsumer made available to provide ideational scaffolding for each component unit of differentiated subject matter but the ideas within each unit as well as the various units in relation to each other are also progressively differentiated—organized in descending order of inclusiveness The initial organizers therefore furnish anchorage at a global level before the learner is confronted with *any* of the new material Thus for example a generalized model of class relationships is first provided as a general subsumer for *all* new classes subclasses and species before more limited subsumers are provided for the particular subclasses or species they encompass

Hence when undergraduates are first exposed to organizers presenting relevant and appropriately inclusive subsuming principles they are better able to learn and retain completely unfamiliar ideational material (Ausubel 1960) Differential analysis in another similar study showed that the facilitating effect of organizers is greatest for those individuals who have relatively poor verbal ability and who therefore tend spontaneously to structure such material less effectively (Ausubel and Fitzgerald 1962) The greater retention by pro-Southern than by pro-Northern students of a controversial passage presenting the Southern point of view on the Civil War can also be explained in terms of the relative availability of appropriate subsuming ideas (Fitzgerald and Ausubel 1963) The pro-Northern students lack relevant subsumers to which the pro-Southern passage can be functionally related The material therefore cannot be clearly and securely anchored to cognitive structure competes with existing meanings and is consequently ambiguous and subject to rapid forgetting The pro-Southern students, on the other hand, possess relevant subsuming concepts, thus the material can be readily anchored to cognitive structure and is less ambiguous and subject to forgetting

## *Integrative Reconciliation*

The principle of integrative reconciliation in programming instructional material can be best described as antithetical in spirit and approach to the ubiquitous practice among textbook writers of compartmentalizing and segregating particular ideas or topics within their respective chapters or subchapters Implicit in this latter practice is the assumption (perhaps logically valid, but certainly psychologically untenable) that pedagogic considerations are adequately served if overlapping topics are handled in self contained fashion, so that each topic is presented in only *one* of the several possible places where treatment is relevant and warranted, the assumption that all necessary cross referencing of related ideas can be satisfactorily performed, and customarily is, by students Hence, little serious effort is made *explicitly* to explore relationships between these ideas, to point out significant similarities and differences, and to reconcile real or apparent inconsistencies Some of the undesirable consequences of this approach are that multiple terms are used to represent concepts that are intrinsically equivalent except for contextual reference, thereby generating incalculable cognitive strain and confusion as well as encouraging rote learning, that artificial barriers are erected between related topics, obscuring important common features, and thus rendering impossible the acquisition of insights dependent upon recognition of these commonalities, that adequate use is not made of relevant, previously learned ideas as a basis for subsuming and incorporating related new information, and that since significant differences between apparently similar concepts are not made clear and explicit, these concepts are often perceived and retained as identical

The principle of integrative reconciliation also applies when subject matter is organized along parallel lines, that is, when related materials are presented in serial fashion but there is no *intrinsic* sequential dependence from one topic to the next Unlike the case in sequentially dependent subject matter, successive learning tasks are inherently independent of each other in the sense that understanding of Part II material does not presuppose understanding of Part I material Each set of material is logically self contained and can be adequately learned by itself without any reference to the other order of presentation is therefore immaterial This situation for example prevails in presenting alternative theoretical positions in ethics, religion, and epistemology, opposing theories of biological evolution and different systems of learning and personality theory

Nevertheless although successive learning tasks of parallelly organized material are not intrinsically dependent on each other much cognitive interaction obviously occurs between them Earlier learned elements of a parallel sequence serve an orienting and subsuming role in relation to later presented elements The latter are comprehended and interpreted in terms of existing understandings and paradigms provided by analogous, familiar, previously learned, and already established ideas in cognitive structure. Hence for learning of the unfamiliar new ideas to take place, they must be *adequately discriminable from the established familiar ideas, otherwise* the new meanings are so permeated with ambiguities misconceptions and confusions as to be partially or completely nonexistent in their own right If, for example the learner cannot discriminate between new idea $A'$ and old idea $A$, $A'$ does not really exist for him, it is phenomenologically the same as $A$ Furthermore even if the learner can discriminate between $A$ and $A'$ at the moment of learning unless the discrimination is sharp and free from ambiguity and confusion there will be a tendency over time for $A'$ to be reduced to $A$ (as the two ideas interact during the retention interval) more rapidly than is usually the case

In some instances of meaningful learning and retention the principal difficulty is not one of discriminability but of apparent contradiction between established ideas in cognitive structure and new propositions in the learning material Under these conditions the learner may summarily dismiss the new propositions as invalid may try to compartmentalize them as isolated entities apart from previously learned knowledge or hopefully may *attempt integrative reconciliation under a more inclusive subsumer* Compartmentalization may be considered a common defense against forgetting in many school learning situations By arbitrarily isolating concepts and information one prevents confusing interaction with and rapid obliterative assimilation by more established contradictory ideas in cognitive structure But this of course is merely a special case of rote learning Through much overlearning relatively stable incorporation may be achieved at least for examination purposes but the fabric of knowledge learned in this fashion remains unintegrated and full of contradictions and is therefore not very viable on a long term basis

A H Ward and R. A Davis (1939) report a study of meaningful retention *in which general science was taught to junior high school pupils by* means of a textbook that made a special point of reconciling and integrating new ideas with previously learned content Periodic examinations were also given which tested knowledge of earlier as well as of recently presented material They found that students retained material as well after 16 weeks as on tests of immediate retention

Organizers may also be expressly designed to further the principle of integrative reconciliation They do this by explicitly pointing out in what ways previously learned, related ideas in cognitive structure are either basically similar to, or essentially different from, new ideas and information in the learning task Hence, for one thing, organizers explicitly draw upon and mobilize all available concepts in cognitive structure that are relevant for and can play a subsuming role in relation to the new learning material This maneuver effects great economy of learning effort, avoids the isolation of essentially similar concepts in separate, noncommunicable compartments, and discourages the confusing proliferation of multiple terms to represent ostensibly different but essentially equivalent ideas In addition, organizers increase the discriminability of genuine differences between the new learning materials and seemingly analogous but often conflicting ideas in the learner's cognitive structure This second way in which organizers purportedly promote integrative reconciliation is predicated on the assumption that if the distinguishing features of the new learning task are not originally salient or readily discriminable from established ideas in cognitive structure, they not only manifest initially low dissociability strength, but also lose it very rapidly because they can be adequately represented by the latter for memorial purposes It is assumed, in other words, that only discriminable categorical variants of previously learned concepts have long term retention potentialities

Thus if an organizer can first delineate clearly, precisely, and explicitly the principal similarities and differences between the new subsuming concepts and principles to be learned on the one hand and similar established ideas in cognitive structure, on the other, it seems reasonable to postulate that the enhanced discriminability of the new anchoring ideas would enable the learner to grasp later the more detailed ideas and information in the learning passage itself with fewer ambiguities fewer competing meanings and fewer misconceptions suggested by the established ideas than would otherwise be possible, and that as these clearer more discriminable, and less confused differentiated new meanings interact with their subsumers and with analogous established meanings during the retention interval, they would also retain their identity longer This is the case both because the differentiated material is learned in a clearer, more stable, and more discriminable fashion in the first place, by virtue of the greater discriminability of the new anchoring ideas under which it is subsumed and because more discriminable subsumers are themselves more stable and hence better able to provide continuing secure anchorage Comparative organizers, for example, have been successfully used in facilitating the meaningful and retention of an unfamiliar passage dealing with Buddhism (Ausubel and Fitzgerald 1961 Ausubel and Youssef, 1963)

More recently organizers have been used to facilitate the learning of controversial ideational material contrary to the established beliefs of the learner The underlying hypothesis of this approach is that selective forgetting under these conditions is not so much a manifestation of selective perception and repression as an indication of the lack of adequate subsumers in cognitive structure for the stable incorporation of such conflicting material In support of this hypothesis and experimental group of Illinois high school students who studied a comparative ideational organizer prior to learning the Southern point of view about the Civil War remembered more of this material than did a control group of students who studied a purely descriptive introductory passage (Fitzgerald and Ausubel 1963)

### *Sequential Organization*

The availability of relevant anchoring ideas for use in meaningful verbal learning and retention may obviously be maximized by taking advantage of natural sequential dependencies among the component divisions of a discipline—of the fact that the understanding of a given topic often logically presupposes the prior understanding of some related topic Typically the necessary antecedent knowledge is more inclusive and general than the sequentially dependent material but this is not always true (for example superordinate learning) In any case by arranging the order of topics in a given subject matter field as far as possible in accordance with these sequential dependencies the learning of each unit in turn not only becomes an achievement in its own right but also constitutes specifically relevant ideational scaffolding for the next item in the sequence

In sequential school learning knowledge of earlier appearing material in the sequence plays much the same role as an organizer in relation to later appearing material in the sequence It constitutes a relevant ideational foundation and hence a crucial limiting condition for learning the latter material when the influence of both verbal ability and general background knowledge is held constant (Ausubel and Fitzgerald 1962) For maximally effective learning however a separate organizer should be provided for each unit of material Thus sequential organization of subject matter can be very effective since each new increment of knowledge serves as an anchoring post for subsequent learning This presupposes of course that the antecedent step is always thoroughly consolidated Perhaps the chief pedagogic advantage of the teaching machine lies in its ability to control this crucial variable in sequential learning

Another advantage of programmed instruction is its careful sequential arrangement and gradation of difficulty which insure that each attained increment in learning serves as an appropriate foundation and anchoring post for the learning and retention of subsequent items in the ordered se quence Adequate programming of materials also presupposes maximum attention to such matters as lucidity organization and the explanatory and integrative power of substantive content

Sequential arrangement of learning tasks relies in part on the *general* facilitating effect of the availability of relevant anchoring ideas in cognitive structure on meaningful learning and retention For any given topic how ever there is the problem of ascertaining what the *particular* most effective sequence is This involves considerations of logical task analysis progressive differentiation developmental level of cognitive functioning integrative re conciliation and learning hierarchies Further in superordinate learning it is essential to insure that both subordinate concepts and propositions and the component conceptual elements of each proposition are previously mastered R M Gagné states the problem very well by saying that

> the planning that precedes effective design for learning is a matter of speci fying with some care what may be called the *learning structure* of any subject to be acquired In order to determine what comes before what the subject must be analyzed in terms of the types of learning involved in it The acquisition of knowl edge is a process in which every new capability builds on a foundation established by previously learned capabilities The importance of mapping the sequence of learnings is mainly just this That it enables one to avoid the mistakes that arise from skipping essential steps in the acquisition of knowledge of a content area (Gagné 1965 pp 25 173)

### *Consolidation*

By insisting on consolidation or mastery of ongoing lessons before new material is introduced we make sure of continued subject matter readiness and success in sequentially organized learning This kind of learning pre supposes of course that the preceding step is always clear stable and well organized If it is not the learning of all subsequent steps is jeopardized Thus new material in the sequence should never be introduced until all previous steps are thoroughly mastered This principle also applies to those *kinds of intra task learning in which each component task (as well as entire* bodies of subject matter) tends to be compound in content and to manifest an internal organization of its own Consolidation of course is achieved through confirmation correction clarification differential practice and review in the course of repeated exposure with feedback to learning ma terial

Abundant experimental research (C P Duncan 1959 Morrisett and Hovland 1959) has confirmed the proposition that prior learnings are not transferable to new learning tasks until they are first overlearned Over learning in turn requires an adequate number of adequately spaced repeti tions and reviews sufficient intra task repetitiveness prior to intra and inter task diversification and opportunity for differential practice of the more difficult components of a task Frequent testing and provision of feed back especially with test items demanding fine discrimination among alter natives varying in degree of correctness also enhance consolidation by confirming clarifying and correcting previous learnings

In directly sequential tasks where the learning of Part II materials pre supposes understanding of Part I materials (where Part II is *sequentially dependent* on Part I) the stability and clarity of the antecedent material crucially affect the learning and retention of the later appearing material (Ausubel and Fitzgerald 1962) [9]

The stability and clarity of existing cognitive structure are important both for the depth of anchorage they provide for related new learning tasks as well as for their effects on the discriminability of these new tasks The discriminability of new learning material as shown by several of the experi ments reported above is in large measure a function of the clarity and stability of existing concepts in the learner s cognitive structure Even in the learning of controversial ideas contrary to prevailing belief (for instance the learning by Illinois students of the Southern point of view about the Civil War) the more knowledgeable students namely those who know more about the Civil War period are better able to learn and remember the other side arguments (Fitzgerald and Ausubel 1963) presumably because they find them more discriminable from established ideas than do less knowledgeable subjects Thus much of the effect of overlearning—both on retaining a given unit of material and on learning related new material—is probably a reflection of the enhanced discriminability that can be induced by increasing the clarity and stability of either the learning material itself or of its subsumers

Much additional research is needed to establish both the most economi cal degree of consolidation and the most efficient ways of effecting it (repeti tion distribution of practice feedback use of organizers internal logic of the material) that will optimally facilitate the learning and retention of sequentially and parallelly organized subject matter Such knowledge will obviously have greater pedagogic utility if the effects of these latter variables are differentiated with respect to pupils level of cognitive maturity academic ability and degree of subject matter sophistication

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[9] Consolidation (through correction and review) of each successive part of a hierarchically organized task does *not* facilitate the *learning* of later segments of the task when a summary and correction review of the *entire* task are made part of the terminal test on the material (M D Merrill 1965) The results of this experi ment are therefore consistent with those of Ausubel and Youssef s (1966) study in which a summary of Part I was presented as an introduction to Part II thereby making Part II *no longer* sequentially dependent upon Part I

## Other Pedagogic Means of Facilitating Transfer

We have presented above some of the principal pedagogic means of facilitating transfer through the manipulation of cognitive structure variables According to this view, the incorporation of clear, stable, and integrative subsumers in cognitive structure is the most efficacious way of promoting transfer Although we have been primarily concerned with meaningful reception learning, the same general principle applies as well to meaningful discovery learning Transferability, in other words, is largely a function of the relevance, meaningfulness, clarity, stability, integrativeness, and explanatory power of the originally learned subsumers Rote learnings have little transfer value But generalizations manifest transferability only when they are thoroughly grasped and overlearned (Mandler, 1954), and take into account the pupil s level of cognitive functioning In elementary school children, this requires the use of concrete-empirical props

Even so, transfer does not take place automatically and without deliberate effort to appreciate and practice the opportunities that are present for transfer in a given learning situation The learner must also perceive the relationship of the training to the criterial task (Ervin, 1960b) Geometry, for example, can increase ability to think logically in other subject matter areas only if awareness of this applicability is *deliberately* induced (Fawcett, 1935, Hartung, 1942 Ulmer, 1939) The same is true of the teaching of genetics to reduce superstitious thinking and racial prejudice [10] and of the transferability of Latin to English and second language learning In all probability, however, the same investment of time in *direct* study of the target languages, as opposed to prior study of Latin would yield more satisfactory learning results Merely telling learners that previous learnings might be useful in other situations increases transfer (Dorsey and Hopkins, 1930)

Transferability also depends upon the application of a principle, during original learning, to as many specific contexts as possible (Hull 1920) C L Hull showed that familiarity with a concept in a large number of different specific contexts and illustrative forms is more efficacious for gen

[10] This does not necessarily imply that a grand heuristic strategy which can be applied to all disciplines is discoverable or that critical thinking ability can be enhanced by teaching general principles of logic apart from specific subject matter content It simply means that in certain instances specific models or analogies may have interdisciplinary heuristic value on a metaphorical basis and that certain substantive or methodological principles have applicability to more than one discipline provided that their interdisciplinary *relevance and implications are made explicit*

eralization than is intensive experience with a few illustrations providing of course that mastery occurs within each context Thus transfer can be facilitated by providing opportunity for learning principles in as wide a variety of situations as possible, by explicitly emphasizing the similarity between training and criterial tasks and by presenting the latter tasks con tinuously or in close succession In the case of vocational learning knowl edge and skill become more transferable when they are learned originally in realistic and real life situations that are similar to the settings in which final utilization of the training will take place

Some tasks are so complex that they cannot be learned directly The learner must be trained first on a simplified version of the task and then transfer this training to an attempt at mastering the task itself (Baker and Osgood 1954) For example in learning a complex tracking task (Lawrence and Goodwin 1954) or oral comprehension of a foreign language initial slowing of the learning task is desirable In some instances the separate components of a very complex performance must be mastered separately before the task as a whole can be attempted with any hope of success (Eckstrand and Wickens 1954)

## Other Theories of Transfer

The cognitive structure theory of transfer we have presented in this chapter is most closely related to C H Judd s (1902) classical generaliza tion theory It differs from the latter mainly in being concerned with the reception learning of subject matter rather than with the application of generic principles to specific instances of problem solving and in being more specific about the nature and conditions of generalization that is in specifying various significant cognitive structure variables It is also some what related to the so-called transposition theory of Gestalt and field theorists which emphasizes *perception of the relationship between prin ciples and specific instances* in the training situation rather than the *process of generalization* Two other theories of transfer however, formal disci pline" and identical elements are markedly different and deserve special scrutiny

### *"Formal Discipline"*

The formal discipline theory of transfer first emerged as a formaliza tion of the belief widespread prior to 1930 that training in such abstract or difficult subjects as Latin Greek natural science and mathematics improves *generally* such hypothetically distinct mental faculties as reasoning memory and concentration E. L. Thorndike (1924) discredited this theory by demonstrating that these abstract subjects have no significantly greater facilitating effect than do shopwork or bookkeeping on tests of selective and relational thinking Similar results were reported by J B Carroll (1940) A Rapp (1945) A G Wesman (1945) and Strom (1960) in testing the effect of prior learning of one school subject on the learning of another

The doctrine of formal discipline is still very much alive as evidenced by the stubborn persistence of studies purporting to improve critical thinking ability or general academic performance by means of instruction in general principles of logic or the study of foreign languages G H Hyram (1957) for example concluded that upper grade elementary school pupils could be taught to think critically and therefore logically through the use of instructional procedures emphasizing principles of logic His findings however provided no evidence of gain in critical thinking ability *beyond* the actual area of training since it was to be expected that pupils instructed in general principles of logic would make significantly higher scores than a matched control group on a test of reasoning based on these same principles R B Skelton (1957) presented data showing that entering college freshman who had studied foreign languages in high school surpassed a comparable control group matched for IQ on English mathematics and history entrance examinations as well as on first year college grades Although these differences between the two groups could not be attributed to the fact that the students electing foreign languages in high school were more intelligent to begin with it does not necessarily follow that foreign language study facilitates general academic achievement by improving ability to comprehend and use English more effectively Much more would have to be known about the relative academic motivations of the two groups before this conclusion were warranted

Although the theory of formal discipline was demonstrably fallacious in its major premise it is nevertheless true that special training in efficient methods of memorization (Woodrow 1927) in work study habits (Leggitt 1934) and in general techniques of efficient work (Cox 1933) are transferable

Furthermore as L J Cronbach points out

> there are many disciplines each of them a way of coming to grips with certain types of problems There is obvious sense in the contention that a mathematician is more competent to solve a new mathematical problem than a bright and educated nonmathematician and not just because the mathematician knows more theorems He has an ability to construct models sense connections within the model and test the internal consistency among premises and conclusions He has a wealth of apparatus at his command—notational systems conceptual distinctions operations These are used not as the computer uses a formula but as an architect uses all that has been learned from past buildings To solve a new problem he draws from his store this and that device that might work juggles them in the air begins to see

a coherence discards some misfit parts and designs some replacements and finds more or less suddenly the shape of his mathematical system (Cronbach 1965 p 129)

### *Identical Elements*

E. L. Thorndike's (1913) view that transfer takes place to the extent that identical elements occur in both training and criterial situations is obviously much too narrow In addition to transfer of identical elements there is also transfer of principles problem solving techniques (Birch and Rabinowitz 1951) work study habits (Leggitt 1934 Ruediger 1908) affectively toned attitudes toward particular subjects skills and learning tasks and such personality related attitudes toward novel tasks as willingness to improvise venturesomeness self-confidence level of aspiration and rigidity

## The Role of Transfer in Education

It is obviously impossible for classroom learning to prepare students to cope with every situation they will face in real life contexts Further even if this were possible the primary goal or function of education still would not be to provide students with knowledge that is applicable to the everyday problems of living Thus social utility objective of education has long since been discarded as impracticable In most instances of non vocational classroom learning the goal of transfer is considered accomplished if prior learning experience facilitates the learning of subsequent classroom learning tasks—even if the knowledge so acquired is neither applicable nor even applied to problems outside the classroom. Of course if the knowledge is applicable to the problems of living, so much the better but this is not the primary objective of transfer in general education

Another relevant issue here as pointed out earlier is that inability to apply knowledge in problem-solving situations is not necessarily proof of lack of understanding of the material in question The ability to apply knowledge successfully in problem-solving situations depends also on many other variables completely unrelated to understanding

In training students for particular professions general theoretical principles are taught in the belief that they have considerable transfer value for the solution of practical professional problems In addition students are trained in specialized problem-solving skills and methods of inquiry How well a particular trainee will be able to utilize his theoretical knowledge in practice however depends on his ability to apply this knowledge in problem solving situations Informal long observation of consistently good and poor problem solvers in the professions suggests that the application component of problem solving ability is less trainable than the knowledge component. It may thus be more feasible to enhance problem solving ability by improving the student s grasp and functional retention of theoretical knowledge than by training him directly in problem solving skills The role of transfer in professional *education will be illustrated in the following* discussion of medical training which offers many obvious parallels to the training of teachers

### *Medical Education*

Perhaps the most distinctive feature of medicine as a profession is the unusually large volume of relevant background knowledge which a medical trainee must first acquire in usable form before he can hope to engage in the actual practice of medicine A central problem of medical education, therefore, is to discover efficacious ways of transmitting this knowledge to students so that it can be retained over long periods of time in the viable and functional condition necessary for successful application to problems of clinical practice

THE PROBLEM OF TRANSFER IN MEDICAL EDUCATION Since a minimal fund of preclinical and clinical background knowledge must be acquired before any serious exposure to clinical problem solving experience is feasible, and since this background knowledge is acquired largely during the two preclinical years and the first clinical year of medical school the educational problem may be conceptualized as one of long term transfer of training How, for example, can the subject matter of the preclinical years be best taught so that it can be retained in usable form and hence be available both as a foundation for learning new bodies of clinical subject matter, and as a basis for clinical problem solving? Obviously preclinical knowledge which is not retained at all or which is retained in a disorganized unclear, nonmeaningful (rote) unstable, or isolated fashion cannot be used effectively for these latter purposes

Yet it is a well known fact that many medical students, especially those with high levels of anxiety cope with the problem of digesting the large volume of material with which they are confronted by memorizing it rotely for examination purposes and by relying compulsively on their lecture notes which often as not are grossly inaccurate Other students narrowly restrict their intellectual horizons to the prescribed textbooks phobically avoiding supplementary readings special lectures and extra curricular activities be cause they fear that additional information or other points of view will add to *the already unmanageable burden of knowledge Both adjustive tech* niques obviously tend to foster a closed minded uncritical attitude toward prevailing doctrines and practices in medicine

TWO TYPES OF TRANSFER Historically speaking the major problem of transfer with which medical educators have grappled has been that of discovering the best way of teaching preclinical subjects so that an adequate residue of relevant and viable knowledge will be retained for later use in learning clinical subject matter and in solving clinical problems The most widely used approach to this problem of maximizing the transferability of preclinical medical knowledge both to clinical subject matter and to problems of clinical practice involves the use of explicit transitional materials and devices During the first preclinical year, for example, some anatomy is presented in the context of its explicit relevance for surgery, physical diagnosis, and clinical neurology, and some aspects of physiology and biochemistry are considered in the context of pathological aberrations encountered in medical practice. During the second preclinical year, such courses as pathology, pharmacology, laboratory diagnosis and physical diagnosis are partly designed so as to constitute a theoretical link between the first year study of normal structure and function, on the one hand, and the clinical understanding and treatment of pathological conditions, on the other Some time is also devoted in the preclinical years to the demonstration and discussion of patients and to clinical pathological conferences

During the clinical years, the articulation of preclinical and clinical background knowledge is approached from the opposite direction. Preceding the discussion of the diagnosis, prognosis, and treatment of clinical entities some attempt is usually made to summarize the relevant anatomy, physiology, and pathology In our opinion, efforts to achieve this type of articulation—in both directions—are extremely worthwhile, have demonstrably efficacious results, and should be extended.

*Another important problem of transfer in medical education is* concerned with the transfer of clinical *background* knowledge (third year lecture courses) to the *particular* diagnostic and therapeutic issues posed by *individual* patients in clinic and hospital practice (senior year clinical clerkships and fifth year internships) However, the problem of transfer here is somewhat different from that of making optimal use of *abstract preclinical* knowledge in the learning of *abstract clinical* subject matter It involves, rather, the optimal utilization of *general* clinical knowledge in *particular problem solving* situations

This second problem of transfer, although no less real and important than the first, is, unfortunately, somewhat less susceptible to educational *manipulation Transfer from one* body of abstract knowledge to another is wholly a cognitive problem. That is the only things that are involved in considering the relationship between success in mastering the preclinical curriculum and success in learning clinical subject matter, are the actual content relationships between the disciplines in question, and the relationships between the quite analogous intellectual abilities needed in the two learning tasks. But the relationship between knowledge of clinical subject matter and success in clinical practice is much more complicated In this instance, the two kinds of learning tasks (learning an abstract body of clinical knowledge and learning to solve the particular clinical problems of individual patients) are less closely related than in the case of the first transfer situation, and the abilities influencing success in the first task are similarly less related to the abilities influencing success in the second task than is true of the earlier described transfer situation

Another way of contrasting these two types of transfer is to say that knowledge of clinical and preclinical subject matter is a necessary but not a sufficient condition for successful clinical problem solving To solve problems of clinical practice successfully, one not only requires a sound background of relevant background knowledge, but also (a) an adequate amount of appropriately organized and supervised clinical experience, and (b) such problem solving traits as resourcefulness problem sensitivity, originality, perseverance, flexibility, improvising ability, and venturesome ness And these latter traits are undoubtedly both more dependent on genic endowment and less teachable than are either background knowledge or strategies of clinical problem solving

It is apparent, therefore, that the problem of transfer from preclinical to clinical knowledge is simpler in terms of the variables involved than is the corresponding problem of transfer from relevant background knowledge (clinical and preclinical) to clinical problem solving Furthermore transfer is more predictable and educationally manipulable in the first situation than in the second In the second situation we can enhance ultimate problem solving ability (diagnostic and therapeutic ability) both by increas ing the stability and usability of relevant background and by providing more adequate and better organized and supervised clinical experience However, we have little control over and cannot materially influence by educational techniques those problem solving traits that are so crucially important for success in any kind of problem solving This same situation obviously pre vails in the training of lawyers, teachers engineers and so forth

APPROACH TO THE ENHANCEMENT OF TRANSFER To summarize three kinds of approaches seem feasible in attacking the transfer problem in medi cal education First we can try to incorporate into the medical curriculum explicit transitional materials and experiences that bridge the gap between the structural and the functional, between the normal and the pathological between basic science knowledge (both normal and pathological) and bodies of clinical knowledge, and between abstract subject matter (both basic science and clinical) and clinical problem solving This use of transitional devices is currently the most widely used approach in medical schools Second we can attempt to enhance the clarity, stability and usability of (a) preclinical subject matter that is retained as a foundation for learning clinical subject matter and (b) both preclinical and clinical knowledge that is available for application to clinical problem solving This second approach is the one that is principally advocated in this book. Third we can endeavor to improve the experiential content, organization and supervision of the student s hospital and outpatient training and to teach more effective strategies of diagnosis and therapeutic decision making This type of supervised clinical problem solving *experience can be considered a special* variant of the first approach that is as a protracted concentrated but nevertheless transitional training device bridging the gap or facilitating transfer between abstract clinical knowledge on the one hand and *independent* clinical practice on the other

Clinical demonstrations beside apprenticeship case study review and diagnostic problem-solving exercises are representative of the last mentioned approach When used intelligently and with full awareness of the realistic limitations involved such techniques are very effective and enjoy an established place among the more promising methods of enhancing the clinical skills of medical trainees One important limitation that must be accepted from the outset is the already emphasized fact that much of the ultimate variability among physicians in clinical problem solving performance reflects genically determined variability in problem-solving traits that are not very susceptible to training measures An equally important limitation involves recognition of the fact that clinical problem-solving techniques can be used only in conjunction with rather than as a substitute for didactic exposition of clinical subject matter Training in particular problem solving situations is much too time-consuming to constitute a feasible method of transmitting the vast array of abstract clinical knowledge medical students are required to know As a matter of fact if problem-solving techniques were misused for this latter purpose they would ultimately prove to be self-defeating because in the absence of adequate background knowledge students could not possibly hope to solve clinical problems successfully irrespective of the adequacy of their practical training Enhanced ability to *solve clinical problems in other words can be regarded as both the major* objective of expository clinical teaching and as a principal criterion of its adequacy but problem solving exercises cannot be considered a practical primary means of teaching the abstract content of clinical subject matter

Despite these limitations however much scope obviously remains for methods to improve the adequacy of clinical training Our advocacy of the second of the three approaches outlined above is largely a reflection both of personal preference and of the judgment that this approach although exceedingly promising is the most neglected of the three It does not in any way imply a derogation of the other two approaches

From the standpoint of the approach adopted herein to the transfer problem in medical education the structure of a student s medical knowledge is regarded as the crucial variable influencing new learning retention and problem solving Only insofar as it is possible to enhance the organization clarity and stability of this structure is it possible to increase the functional retention of medical knowledge so that both more preclinical subject matter is transferable to the learning of clinical subject matter and more abstract clinical knowledge is available for particular clinical problem solving situations Cognitive structure itself as indicated above can be influenced substantively by the generality and integrative properties of the particular organizing and explanatory principles used in a given branch of medicine and programmatically by methods of presenting arranging and ordering units of medical knowledge that impinge on the clarity stability and cohesiveness of that structure

## The Facilitating Effect of Verbalization in Transfer

We have already considered the general facilitating role of language in cognitive functioning as well as the mediating function of implicit verbal responses in concept formation R L R Overing and R M W Travers (1966) found that verbalization of general principles prior to application facilitates problem solving Building on the earlier work of P H Ewert and J F Lambert (1932) R M Gagné and E C Smith (1962) also demonstrated the positive effect of verbalization on the discovery of general principles and on their transferability to problem solving especially in relation to more difficult problems Their study deals with the verbal nonverbal dimension of learning rather than with the reception discovery or rote meaningful dimensions It has important implications for pedagogic practice because the findings challenge the widely accepted tenet of progressive education that verbal learning is necessarily rote in character and that only nonrepresentational experience is transferable from one problem solving situation to another Although it is true that expository teaching and reception learning are typically verbal discovery learning as Gagne and Smith (1962) point out may be either verbal or nonverbal Their isolation of the verbal nonverbal variable from the reception discovery and rote meaningful variables represents an important methodological advance in the study of problem solving L E Thune and S C Ericksen (1960) report basically similar findings When their subjects had sufficient concrete experience with the learning task (operating a calculator) generally to understand it abstract instruction about the mechanism of a calculator was more efficacious in a transfer situation than specific operating experience on a single calculator

S M Ervin (1960c) also found that verbal instruction in the relevant physical principles underlying a motor task increases transfer to an analo widely known information are related aspects of cognitive style Although preference for cognitive complexity cannot be reduced to any simple dimension of cognitive functioning it does exhibit considerable generality (Vannoy 1965) As one might reasonably anticipate it increases in direct proportion to an individual's *ability to process or code variability* (Munsinger and Kessen 1964) Individuals preferring cognitive simplicity are differentially more sensitive to new information and are thus more likely to change initial impressions (Leventhal and Singer 1964) Elementary school pupils who prefer little known to more widely known information are more attracted to novelty and challenge and are also more likely to choose intellectual vocations (Teeter Rouzer and Rosen 1964)

According to J S Bruner and H Tajfel (1961) learners seem to manifest a consistent preference for broad or narrow categorization Narrow categorizers show greater preference than broad categorizers for taking the risk of being wrong as stimulus situations change J Kagan H A Moss and I E Sigel (1963) describe self consistent analytic descriptive, inferential descriptive and relational tendencies among children in grouping pictures The first named tendency increases with age and is more characteristic of boys than of girls Children with analytic tendencies tend to be more reflective with respect to alternative classification possibilities and to analyze visually presented material more into their component parts (Kagan Rosman Kay Albert and Phillips 1964) They also tend to be less hyperactive and distractible Children who are conceptually reflective tend to make fewer errors in reading and inductive reasoning than do children who are conceptually impulsive (Kagan 1965 Kagan Pearson and Welch 1966)

Although it is probably true that human beings tend to organize the world of ideas people and authority basically along lines of belief congruence [and that] what is not congruent is further organized in terms of similarity to what is congruent (Rokeach 1960 p 395) interindividual differences obviously exist with respect to the need for internal consistency within belief systems Some individuals are undoubtedly more content than others to internalize contradictory propositions in logic tight compartments rather than to subject them to integrative reconciliation However direct research evidence regarding the stability and generality of such individual differences is presently unavailable

Another way of maintaining ideational self consistency is peremptorily to reject all new propositions that appear incongruent with existing beliefs M Rokeach (1960) obtained evidence of a generalized open-closed dimension of belief systems measured by the Dogmatism and Opinionation Scales with respective reliability coefficients of approximately 80 and 70 In validating these scales he found that Catholics make high Dogmatism and Right Opinionation scores whereas Communists and religious disbelievers make high Dogmatism and Left Opinionation scores Only the Right Opinionation groups however tend to score high on the Berkeley Authoritarianism Scales Closed and rigid individuals experience difficulty in synthetic and analytic thinking respectively Open minded individuals tend to score higher than closed minded individuals on tests of verbal ability school achievement and ability to form remote verbal associations (S R Baker 1964 Zagona and Zurcher 1965) J McV Hunt (1961) in a review of the literature suggested that a large amount of prior experience in a given area promotes a positive orientation to novel situations whereas little prior experience in the same area is more likely to lead to withdrawal Along the same line individuals tend to differ consistently in their tolerance for unrealistic experiences (Gardner and Schlesinger 1962)

Intolerance of ambiguity is a characteristic manifestation of the relatively closed mind and is symptomatic of high anxiety level (Ausubel 1949 Smock 1957) The anxious individual who requires immediate and clear cut answers and is impatient with conflicting evidence and tentative conclusions tends to exhibit either excessive impulsiveness or excessive cautiousness in decision making (Smock 1957) Both early and late decision makers manifested significantly more response perseveration and shorter latency of response on an object recognition test than did a middle group (Smock 1957 p 35) High causally oriented children are more tolerant of such perceptually ambiguous materials as are presented in the Decision Location Test and have less of a tendency to arrive at premature closure than low causally oriented subjects (Muus 1960 p 534) The latter tend to make more guesses and their guesses are more likely to be rigid and judgmental in character

Individuals also differ consistently with respect to their tendency to use affect labels in categorizing stimuli In an investigation of intra individual consistency in the use of affect labels in describing and categorizing social and ink blot stimuli J Kagan H A Moss and I E Sigel (1960) were able to demonstrate significantly positive intercorrelations among their four measures

Gardner (1959) employing a factor analytic approach isolated a limited number of control principles reflective of individual consistencies in cognitive behavior This study was later broadened to include tests of intellectual ability and personality variables (Gardner Jackson and Messick 1960) On the basis of their findings these investigators conclude that intellectual abilities and cognitive controls are not isolated aspects of cognitive organization but are mutually interrelated The arbitrary distinction that has sometimes been maintained between intelligence and the broad scale organization of cognition thus seems inappropriate (Gardner Jackson and Messick 1960 p 123)

Retention style was studied by I H Paul who found general and consistent individual differences with respect to importation amount of material retained and the use and retention of imagery

> Importing sometimes was clearly explicatory in function (assimilating and con necting) at other times merely decorative and extraneous (sharpening) Interest ingly enough for the nonimporters it *rarely* seemed to be the latter most of the decorative importations were contributed by the importers (Paul 1959 p 144)
>
> The reproductions of nonimporters and importers were stylistically different the former were generally leaner in structure more disconnected and more abbre viated than those of tl e importers the latter seemed more continuous and coherent (Paul 1959 p 135)

It is quite probable that consistent individual differences exist with regard to strategy of and general approach to problem solving Although a particular strategy of concept acquisition (simultaneous scanning succes sive scanning conservation focusing or focus gambling) is generally more likely to occur under some experimental conditions than under others (Bruner 1956) it is also possible that self consistent and generalized indi vidual preferences are concomitantly operative

The issue of flexibility rigidity in problem solving has also received considerable attention A S Luchins and E H Luchins (1959) in review ing the literature on rigidity of behavior and the effect of *Einstellung* (ad vance cognitive sets) assert that no conclusions are possible at this time as to whether a general and self consistent factor of rigidity exists The intratask generality of individual differences in the Water Jar *Einstellung* Test has not yet been determined and the validity of this measure as well as its relationship both to other measures of rigidity and to other personality traits are highly equivocal

Chapter 5

# COGNITIVE DEVELOPMENT AND READINESS

WE HAVE HAD OCCASION TO NOTE previously that, unlike a computer, the information processing and storing capacities of the human being change as a function of age and experience In this chapter we propose to consider cognitive development and developmental readiness as factors in meaningful learning and thinking Emphasis will be placed on the changes in intellectual development that take place from kindergarten through high school and on their implications for school learning and pedagogy, intellectual development during infancy and the preschool period is not germane to educational psychology except where it pertains to school learning issues In Chapter 4, readiness, as a *developmental* mode of cognitive functioning, was differentiated from the readiness that reflects possession of particular *subject matter* knowledge, or adequate subject matter sophistication, for particular learning tasks In this chapter the term readiness' will be used only in a developmental sense

Readiness is a cumulative developmental product reflecting the influence of all genic effects all prior incidental experience, and all prior learning on cognitive patterning and the growth of cognitive capacities Thus it reflects the effects of subject matter learning as well, but only its *general* effects on *cognitive capacities* or *mode of cognitive functioning*, as distinguished from the acquisition of the *particular* learnings that constitute the basis of subject matter readiness In any particular instance of readiness, any one or all of these factors may be involved Readiness may be general in the sense that an individual manifests a certain level of cognitive functioning required for a wide range of intellectual activities On the other hand, it may be limited to the highly particularized cognitive capacities necessary for the learning of a narrow segment of new subject matter, and even to the particular teaching method employed in acquiring that knowledge

## The Nature of Readiness

Cognitive readiness refers to the adequacy of existing cognitive processing equipment or capacity for coping with the demands of a specified cognitive learning task Empirically readiness is indicated by ability to profit from practice or learning experience An individual manifests readiness when the outcomes of his learning activity in terms of increased knowledge or academic achievement, are *reasonably commensurate* with the amount of effort and practice involved Readiness in the developmental sense of the term is a function of general cognitive maturity General cognitive maturity in turn largely reflects age level differences in intellectual capacity or stage of intellectual development In any particular individual of course it also reflects individual differences in genic potentiality incidental experience intellectual stimulation and educational background

The particular kind of subject matter that an individual studies induces two main classes of effects On the one hand it determines his *specific* readiness for *particular* other kinds of subject matter learnings that is the type of subject matter sophistication we considered in Chapter 4 under cognitive structure variables On the other hand it also contributes to *general* changes in cognitive readiness that are at least in part independent of the kind of subject matter studied For example the study of elementary school science prepares a pupil for high school science and the study of elementary school grammar prepares a pupil for high school grammar In addition however experience with each subject contributes to his *general* cognitive development and helps determine the *general* level of his cognitive functioning In the present chapter we shall be concerned with these general developmental changes in readiness

Thus in appraising cognitive readiness we would consider all relevant age level changes in ability to cope with different kinds and levels of subject matter that are reflective of growth in cognitive capacity or mode of cognitive functioning Examples of such changes in cognitive capacity that influence learning retention and thinking processes and hence influence developmental readiness for learning different kinds and levels of subject matter include the following increased widening and complexity of the cognitive field increased familiarity of the psychological world greater differentiation of cognitive structure greater precision and specificity of meanings the possession of more abstract higher-order concepts and transactional terms greater ability to comprehend and manipulate abstractions and relationships between abstractions—without recent or current reference to concrete-empirical experience greater ability to deal with general propositions apart from particularized contexts decreased subjectivity in approach to experience increased attention span and increased differentiation of intel lectual ability Some of these changes in cognitive sophistication (increased differentiation of cognitive content, structure, and intellectual ability, greater precision and specificity of meanings) have self-evident implications for general developmental readiness insofar as it bears on the breadth depth issue in curriculum

There is little disagreement about the fact that cognitive readiness always crucially influences the efficiency of the learning process, and often determines whether a given intellectual skill or type of school material is learnable at all at a particular stage of development Most educators also implicitly accept the proposition that an age of readiness exists for every kind of learning Postponement of learning experience beyond this age of readiness wastes valuable and often unsuspected learning opportunities, thereby unnecessarily reducing the amount and complexity of subject matter content that can be mastered in a designated period of schooling On the other hand when a pupil is prematurely exposed to a learning task before he is adequately ready for it, he not only fails to learn the task in question (or learns it with undue difficulty) but also learns from this experience to fear, dislike, and avoid the task

Up to this point the principle of readiness—the idea that attained developmental capacity limits and influences an individual s ability to profit from current experience or practice—is empirically demonstrable and conceptually unambiguous Difficulty first arises when it is confused with the concept of *maturation*, and increases when the latter concept, in turn, is equated with a process of internal ripening The concept of readiness simply refers to the adequacy of existing cognitive *capacity* or level of cognitive functioning (not knowledge) in relation to the demands of a given learning task No specification is made as to how this capacity is achieved —whether through prior learning activities through incidental experience through genically regulated changes or through various combinations of these factors Maturation on the other hand has a different and much more restricted meaning It encompasses those increments in capacity that take place in the demonstrable absence of specific practice experience that is those increments that are attributable to genic influences and/or incidental experience Maturation therefore, is not the same as readiness but is merely *one* of the two principal factors (the other being learning) that contribute to or determine the organism s developmental readiness for coping with new learning tasks Whether or not readiness exists in other words does not necessarily depend on maturation alone in many instances it is solely a function of cumulative prior learning experience and most typically it depends on varying proportions of maturation and learning

To equate the principles of readiness and maturation not only muddies the conceptual waters but also makes it difficult for the school to appreciate that insufficient readiness may often reflect cognitive immaturity on the part of pupils that is attributable to a generally unstimulating, inappropriate, or inefficient educational environment. Lack of maturation can thus become a conveniently available scapegoat whenever children manifest insufficient developmental readiness to learn, and the school, which is thereby automatically absolved of all responsibility in the matter, consequently fails to subject its instructional practices to the degree of self-critical scrutiny necessary for continued educational progress. In short, while it is important to appreciate that the current readiness of pupils determines the school's current choice of instructional methods and materials, it is equally important to bear in mind that this readiness itself is partly determined by the general appropriateness and efficiency of the previous instructional practices to which pupils have been subjected. The quality of education a pupil receives, in other words, is a significant determinant of his *developmental* readiness as well as of his subject matter readiness for further learning.

The conceptual confusion is further compounded when maturation is interpreted as a process of "internal ripening" essentially independent of *all* environmental influences, that is, of *incidental experience* as well as of learning. Readiness then becomes a matter of simple genic regulation unfolding in accordance with a predetermined and immutable timetable, and the school, by definition, becomes powerless to influence developmental readiness—even through a preschool or kindergarten program of providing incidental background experience preparatory to the introduction of more formal academic activities.

Actually, A. Gesell's embryological model of development implicit in the "internal ripening" thesis fits quite well when applied to the sensorimotor and neuromuscular sequences taking place during the prenatal period and early infancy. In the acquisition of simple behavioral functions (for instance, locomotion or prehension) that more or less uniformly characterize all members of the human species irrespective of cultural or other environmental differences, the evidence indicates that for all practical purposes genic factors largely determine the direction of development. Environmental factors influence developmental outcome only if they are extremely deviant, and then serve more to disrupt or arrest the ongoing course of development than to generate distinctive developmental progressions of their own. Thus the only truly objectionable aspect of the embryological model is its unwarranted extrapolation to those more complex and variable components of later cognitive and behavioral development where environmental factors make important contributions to the direction, patterning, and sequential order of all developmental changes.

It is hardly surprising, therefore, in view of the tremendous influence on professional and lay opinion wielded by Gesell and his colleagues, that many educators conceive of readiness in absolute and immutable terms and thus fail to appreciate that, except for such traits as walking and grasping the mean age of readiness can never be specified apart from relevant environmental conditions Although the model child in contemporary America may first be ready to read at the age of 6½ (Morphett and Washburne 1931) the age of reading readiness is always influenced by cultural subcultural and individual differences in background experience and in any case varies with the method of instruction employed and the child s IQ Middle class children for example are ready to read at an earlier age than lower class children because of the greater availability of books in the home and because they are read to and taken places more frequently (Milner 1951) Exposure to television has undoubtedly decreased the age of readiness for reading in recent years but even so the typical child of average intelligence is not ready for formal instruction in reading prior to entering kindergarten (Kinsella 1965)

### *Pedagogic Applications of the Readiness Principle*

By virtue of his distinctive degree of cognitive sophistication at every age level the child has a characteristic way of approaching learning material and viewing the world (Bruner 1960) The pedagogic problem in readiness is to manipulate the learning situation in such a way that one takes account and optimal advantage of existing cognitive capacities and modes of assimilating ideas and information as for example the learner s objectivity subjectivity his level of generality or particularity and the abstractness and precision of his conceptualizations The task of teaching a subject to a child at any particular age is one of representing the structure of that subject in terms of the child s way of viewing things The task can be thought of as one of translation (Bruner 1960)

The objection has been offered that we can have no *direct* knowledge of an individual s state of developmental readiness and that we would therefore be better advised to ignore these factors and manipulate other learning variables about which we have more direct knowledge and over which we have more direct control for instance situational and interpersonal variables reinforcement attributes and organization of the learning task and the conditions of practice All of these latter variables can be manipulated independently of any reference to the existing cognitive capacities of the learner But although it is true that we can have no *direct* knowledge of and control over his state of readiness we should not be unduly discouraged We can still make some fairly shrewd and accurate inferences about existing cognitive readiness from detailed knowledge of the learner s family cultural social class and educational background and from the use of diagnostic testing procedures Furthermore we can also exercise some control over the readiness factor by providing a pertinent background of incidental experi ence or special preparatory learning activities at the desired level of sophistication

Much more significant in terms of pedagogic applications is the serious dearth of research on the cognitive aspects of readiness We desperately need studies indicating that certain kinds components and levels of subject matter which cannot be learned efficiently at one age level can be learned efficiently at another age level studies which achieve superior learning by taking general or particularized readiness factors *into account and studies* showing that more difficult kinds and levels of subject matter—ordinarily not learnable at younger ages—can be learned successfully and without inordinate effort if appropriate changes in teaching method are made Until the principle of readiness is particularized in each academic discipline with respect to the various sub areas levels of difficulty and methods of teaching that can be most advantageously employed at each level of development the principle will have little pedagogic utility

What light can the field of human growth and development throw on the issue of What shall the schools teach? We earnestly wish that it were possible to list and discuss a dozen or more instances in which developmental principles have been validly utilized in providing definitive answers to questions dealing with the content and organization of the curriculum Unfortunately however it must be admitted that at the present time this discipline can only offer a limited number of very crude generalizations and highly tentative suggestions bearing on this issue In a very general sense of course it is undeniable that concern with child development has had a salutary effect on the educational enterprise It alerted school administrators to the fact that certain minimal levels of intellectual maturity are necessary before various subjects can be taught with a reasonable degree of efficiency and hope of success and it encouraged teachers in presenting subject matter to make use of the existing interests of pupils to consider their point of view and to take into account prevailing limitations in command of language and grasp of concepts On the other hand premature and wholesale extrapolation of developmental principles to educational theory and practice has also caused incalculable harm It will take at least a generation for teachers just to unlearn some of the more fallacious and dangerous of these over generalized and unwarranted applications

Much of the aforementioned difficulty proceeds from failure to appreciate that human growth and development is a pure rather than an applied science As a pure science it is concerned with the discovery of general laws about the nature and regulation of human development *as an end in itself* Ultimately of course such laws have self-evident implications for the realization of practical goals in such fields as education child rearing and guidance In a very *general* sense for example they indicate the effects of different interpersonal and social climates on personality development and the kinds of teaching methods and subject matter content that are most compatible with developmental capacity and mode of cognitive functioning at a given stage of growth Thus because it offers important insights about the changing intellectual and emotional capacities of children as developing human beings child development may legitimately be considered one of the basic sciences underlying education and guidance and as part of the necessary professional preparation of teachers—in much the same sense that anatomy and bacteriology are basic sciences for medicine and surgery

Highly detrimental in their effects on pupils and teachers however have been the consequences of far fetched and uncritical extrapolation to educational practice of developmental generalizations that either have not been adequately validated or which apply only to a very restricted age segment of the total span of children s development Two illustrations of the latter category of unwarranted extrapolation of highly limited generalizations—the internal ripening theory of maturation and the principle of self selection —have already been discussed An example of a widely accepted but inadequately validated developmental principle frequently cited to justify general or overall ability grouping of pupils is the proposition that a child s growth and achievement show a going togetheredness (Olson and Hughes 1943) Actually except for a spuriously high correlation during infancy the relationship between physical status and motor ability on the one hand and intelligence and intellectual achievement on the other hand is negligible and declines consistently with increasing age Even among the different sub tests of intelligence and among the different areas of intellectual achievement the weight of the evidence indicates that as a child grows older his component rates of growth in these various functions increasingly tend to diverge from each other

POSTPONEMENT AND PREMATURE LEARNING Intellectual training should not be postponed merely on the theory that an older child can invariably learn anything more efficiently than a younger child Instruction in typing (Wood and Freeman 1932) for example is more successful at age 7 than at age 5 but this is insufficient reason in and of itself to postpone this activity for two years *Adequate* readiness rather than age by itself is the relevant criterion Waiting beyond the point of adequate readiness means that certain specific learnings (as well as the accompanying more general gains in capacity) that could easily have been acquired in the interim if attempted unnecessarily fail to take place

The acquisition of many intellectual achievements that lie within the capability of children but for which they are not adequately ready can be accelerated by providing suitable contrived experience specially geared to their cognitive capacity and mode of functioning The age at which children *can* learn a given intellectual task (like the age of adequate readiness itself) is, after all, not an absolute, but is always relative, in part, to the method of instruction employed (Gates, 1937) By taking advantage of the preschool child s curiosity and urge to explore, by placing extensive reliance on overt manipulative activity in understanding and using symbols, and by programming stimulation at appropriate rates and in suitable forms, M Montessori (Rambusch, 1962), O K Moore (Pines, 1963) and W Fowler (1962) have been able to advance considerably the typical age of reading and writing [1]

Similarly, by using an intuitive approach, it is possible successfully to teach the elementary school child many ideas in science and mathematics (Arnsdorf, 1961, Brownell, 1960, Bruner, 1960, O L. Davis, 1958, Dienes, 1964) that were previously thought much too difficult However, one must balance against the possible advantages of early intuitive learning the high risk of failure and excessive time and effort cost involved in many *premature* instances of such learning Where genuine readiness is lacking it is more feasible in the long run to postpone entirely the introduction of particular subject matter fields until children are cognitively more mature The decision regarding readiness must be based, in each case, upon the findings of particularized research In one progressive school, for example, children who learned no formal arithmetic until the fifth grade equalled matched controls in computation by the seventh grade and surpassed them in arithmetic reasoning (Sax and Ottina, 1958)

A good case can be made for the proposition that modern nursery schools and kindergartens fail to provide children with sufficient intellectual stimulation or that preschool children are *adequately ready* for more than they are taught (Pines, 1963, Wann, Dorn, and Liddle 1962) Enrichment of the preschool curriculum so that it is more commensurate with existing levels of readiness is therefore quite defensible But

> even if it be demonstrated that young children *can* learn this or that advanced process we should still need to decide whether it is desirable and appropriate for them to do so Sociologically we may ask whether this is the best way for children to spend their time and energy Intellectually we may ask whether this is the most suitable preparation for future intellectual activities Emotionally we may ask whether early systematic instruction in reading mathematics or what have you will have a harmful effect upon motivation or upon personal and social behavior The point we are trying to make here is simply this Just the fact that children *can* learn this or that does not *by itself* mean that we therefore, must *require* them to do so at some young age or in some early grade (F T Tyler, 1964 pp 223 224)

[1] That preschool children are able to learn to read is not so surprising when one considers that they do after all learn spontaneously to understand and use *representational auditory stimuli* (the denotative and syntactical meanings conveyed by words and sentences)

The crucial issues in other words are whether such early learning is reasonably economical in terms of the time and effort involved and whether it helps children *developmentally* in terms of their total educational careers The concept of readiness does stipulate a reasonable economy in learning time and effort and warns against the risk and consequences of failure in instances of premature learning As will be pointed out later, however, instruction in reading for culturally deprived children probably does *prevent* later retardation in reading

## The Effects of Environmental Deprivation on Cognitive Development

What theoretical grounds and relevant evidence do we have for believing that prolonged environmental deprivation induces retardation in intellectual development? It is reasonable to assume in the first place that whatever the individual s genic potentialities are cognitive development occurs largely in response to a variable range of stimulation requiring incorporation accommodation adjustment and reconciliation The more variable the environment to which individuals are exposed the higher is the resulting level of effective stimulation D O Hebb (1949) stresses the importance of early sensory and perceptual experience for later problem solving and J Piaget (1952a) similarly emphasizes the importance of such experience for the early stages of intellectual development Characteristic of the culturally deprived environment however is a restricted range and a less adequate and systematic ordering of stimulation sequences (Deutsch 1963) The effects of this restricted environment include poor perceptual discrimination skills inability to use adults as sources of information correction and reality testing and as instruments for satisfying curiosity an impoverished language symbolic system and a paucity of information concepts and relational propositions (Deutsch 1963)

Both the animal and human evidence indicates that early environmental deprivation stunts intellectual development Cage reared rats (Forgus 1954 Gibson and Walk 1956 Hebb 1949) and dogs (Thompson and Heron 1954) who are deprived of visual and exploratory experience are significantly inferior to pet reared control animals in later problem solving ability When monkeys are deprived of stimulation during infancy they tend to become inactive to avoid exploration of the environment and to prefer visual and manipulatory stimuli of low complexity (Sackett 1965) and when kittens are placed in a complex free (simplified) environment they exhibit inferior maze learning ability and less activity (Wilson Warren and Abbott 1965) The longer children remain in substandard environmental conditions—in foundling homes (Freud and Burlingham 1944 Spitz

1945 1949) in orphanages (Dennis and Najarian 1957, Skeels and Fillmore, 1937, Skeels, and others 1938), or with mentally retarded mothers (Speer, 1940) the progressively lower their IQ s become in comparison with the IQ s of control children placed in more favorable environments

These findings are consistent with the reports of progressive decline in the intelligence test scores of isolated mountain and canalboat children who also grow up in unstimulating and nondemanding intellectual environments (Asher, 1935, H Gordon 1923 Sherman and Key, 1932, Wheeler, 1942), with the lower IQ s of rural than of urban children (Asher, 1935, Ausubel 1965g), Chapanis and Williams, 1945, Wheeler, 1942), with the social class differential in IQ (Bayley and Jones 1937, Terman and Merrill, 1937), with the upgrading effect of urban residence on Negro children s IQ s (Klineberg 1935), and with the high correlation between the intra pair discrepancies in the IQ s of separated monozygotic twins and the discrepancies in their educational advantages (Newman, Freeman and Holzinger, 1937) Evidence of depressed IQ of special retardation in language skills and conceptualization and of inability to concentrate is found as late as adolescence among children who spend varying periods of their early years in foundling homes (Goldfarb 1945, Provence and Lipton, 1962)

It is one thing however to appreciate that lack of adequate intellectual stimulation in the preschool years may stunt later intellectual ability, and quite another to assert that critical periods exist for the learning of particular intellectual skills that young children are invariably better able than adolescents or adults to learn *any* subject matter material, or, according to O K Moore, that the human being is *extraordinarily* open and receptive to learning between the ages of 2 and 5 (Pines, 1963)

### *Language Retardation*

It is in the area of language development and particularly with respect to the abstract dimension of verbal functioning that the culturally deprived child manifests the greatest degree of intellectual retardation Many factors contribute to this unfortunate developmental outcome The culturally deprived home to begin with lacks the large variety of objects utensils, toys, pictures and so forth that require labeling and serve as referents for language acquisition in the middle-class home The culturally deprived child is also not spoken to or read to very much by adults[2] Both for this reason

[2] In this connection it is interesting to note that A Anastasi and C de Jesus (1953) attribute the relative language superiority of Puerto-Rican nursery school children over comparable white and Negro children in New York City slum areas—in the face of more severe socioeconomic handicaps—to the fact that they enjoy more contact with adults in the home

and because of the high noise level of his home his auditory discrimination tends to be poor Unlike the middle class child he receives little corrective feedback regarding his enunciation pronunciation and grammar (Deutsch 1963 John and Goldstein 1964) and the vocabulary and syntactical model provided him by his parents is typically impoverished and faulty

Various interpersonal aspects of adult child communication and social control in the lower class home also contribute to language retardation (Hess and Shipman 1965) The lower-class mother s verbal behavior style in communicating with her offspring is typically restricted that is her speech tends to be abbreviated lacking in precision and explicitness and undifferentiated with respect to person topic and circumstances This tendency toward constriction is further compounded by a style of social control in which parental decisions are arbitrary and are justified by an appeal to authority and status differences rather than explained and justified by an appeal to reason and equity In a social environment that offers a very narrow range of alternatives of thought and action there is little opportunity for learning precise and differentiated linguistic expression But although the social use of language is constricted in lower class families it is at least more adequate than the virtually nonexistent cognitive use of language Lower class parents unlike their middle class counterparts use language primarily as a means of expressing their feelings and controlling the behavior of their children and not as a means of communicating ideas (naming identifying comparing explaining clarifying differentiating) (Bereiter and Engelmann 1966)

Later on when new concepts and transactional terms are largely acquired verbally by definition and context from speech and reading rather than by abstraction from direct concrete experience the culturally deprived child suffers from the paucity of abstractions in the everyday vocabulary of his elders from the rarity of stimulating conversation in the home from the relative absence of books magazines and newspapers in his surroundings and from the lack of example of a reading adult in the family setting

It is small wonder therefore that the abstract vocabulary of the culturally deprived child is deficient in range and precision (Deutsch 1963 McCarthy 1930 Schulman and Havighurst 1947 M E Smith 1933) that his representational functioning is deficient (Sigel and McBane 1966) that his grammar and language usage are shoddy that his attentivity and memory are poorly developed and that he is impoverished in such language related knowledge as the number concepts self identity information and understanding of the physical geometric and geographical environments (Deutsch 1963 Sigel and McBane 1966) Social class differences in language and conceptual measures also tend to increase with increasing age (Deutsch 1963) thus demonstrating the cumulative effects of both continued environmental deprivation and of early deficit in language development

The culturally deprived child's entire orientation to language is also different from that of the middle-class child. He responds more to the concrete, tangible, immediate, and particularized properties of objects and situations rather than to their abstract, categorical, and relational properties (Bernstein, 1958, 1960, Siller, 1957). His speech is instigated more by the objects and actions he sees than by abstract ideas emanating from within, and he makes more ancillary use of such nonverbal forms of communication as gestures and facial expressions (Bernstein, 1958, Riessman, 1962). In short, the language of the culturally deprived child is more concrete, expressive, and informal than that of the middle-class child, showing signs of impoverishment mainly in its formal, abstract, and syntactical aspects (Bernstein, 1960, Deutsch, 1963). His sentences are short, staccato-like, and heavily interlaced with slang and cliches, they are rarely compound or complex in structure (Bernstein 1960 Deutsch, 1963). He uses few conjunctions, adjectives, adverbs, and qualifying phrases or clauses.

The most important consequence of the culturally deprived child's language retardation, however, is his slower and less complete transition from concrete to abstract modes of thought and understanding. This transition takes place more slowly and less completely for two reasons. First, the *culturally deprived child lacks the necessary repertoire of clear and stable* abstractions and transactional terms (conditional conjunctives, qualifying adjectives) that is obviously prerequisite for the direct manipulation and understanding of *relationships* between abstractions. Second, for lack of adequate practice he has not acquired sufficient facility in relating abstractions to each other *with* the benefit of concrete-empirical props, so that he can later dispense with their assistance at the same age of his environmentally more favored contemporaries. Because concrete thought operations are necessarily more time-consuming than their abstract verbal counterparts and also because of his distractibility, unfamiliarity with formal language, impaired self-confidence and unresponsiveness to time pressure, the culturally deprived child typically works more slowly than the middle-class child in an academic setting (Chapanis and Williams 1945).

## *Schooling and Intellectual Development*

We still lack firm evidence concerning the influence of an optimal learning environment on the intellectual development of culturally deprived elementary school and adolescent children, especially those who have been subjected for many years to the frustration and demoralization of inappropriate school experience.[3] This is an extremely urgent research problem

[3] Some tangential evidence concerning the ameliorative effect of school experience on intellectual development comes from studies showing that the resump-

that should engage our immediate attention We need to investigate the effects of an optimal learning environment on both IQ scores and on the acquisition of school knowledge, making special efforts to eliminate errors of measurement associated with test content bias, test taking skills, test rapport, and test motivation Generalizing deductively, one might anticipate that school knowledge would be more ameliorable than intelligence level to the influence of environmental stimulation

### *Mechanisms Mediating Irreversibility*

THE CRITICAL PERIODS HYPOTHESIS An increasingly more popular explanation that has been advanced in recent years to account for the apparent irreversibility of certain kinds of behavioral development and developmental retardation is the "critical periods" hypothesis According to this hypothesis, irreversibility of behavioral development is a function of extreme susceptibility to particular types of stimulation during those brief periods in individual development when certain types of behavior are shaped and molded for life By the same token, if the individual is deprived of the necessary stimulation during the critical period, when he is maximally susceptible to it in terms of actualizing particular potential capacities or developing in new directions, it is held that some degree of permanent retardation is inevitable (that he never or only partly can attain the capacities in question) Numerous examples of the existence of critical periods can be found in the perceptual, motor, and social development of infrahuman mammals Infant chimpanzees isolated from normal tactual stimulation exhibit defective kinesthetic learning and cutaneous localization (Nissen, Chow, and Semmes 1951), and if reared in darkness, they fail to fixate or recognize familiar objects or to blink in response to a threatening object (Riesen, 1947) Newly born domestic lambs, reared on a bottle and isolated from sheep for ten days, experience difficulty later in adjusting to the flock and tend to graze by themselves (Scott, Fredericson, and Fuller, 1951) Similarly, puppies isolated for nine weeks or more are unable to adapt socially to other dogs, and if they are not removed from the litter by three months of age, they are extremely difficult to tame at a later date (Scott and

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tion of regular schooling in Holland after World War II raised the mean IQ of children (de Groot, 1948 1951) and that long term improvement in substandard school conditions raised the mean IQ among Hawaiian (S Smith 1942) and East Tennessee mountain children (Wheeler 1942) Current remedial programs for culturally deprived children attending school undertaken as part of the anti poverty movement tend to be global action programs rather than controlled research studies that can yield valid evidence regarding the efficacy of any particular cognitive or motivational aspect of remediation

Marston 1950) Imprinting in animals is also a manifestation of the critical periods phenomenon An isolated new born duck for example will slavishly follow the first object or creature that moves (R. D Hess 1959) High susceptibility to stimulation during this period accounts both for the nonspecific nature of the imprinted response and for its canaliza tion (its pre-emption of the response category in question) the latter fea ture of course also reflects the animal s isolation from competing stimuli

An implicit form of the critical periods hypothesis was applied to intellectual development many years ago by M Montessori and her followers to justify the particular graded series of learning tasks which children are set in Montessori schools (Rambusch 1962) More recently it has been invoked by advocates of the proposition that young children can learn many intellectual skills and kinds of subject matter more efficiently than adults can The argument in both instances is that since there are allegedly optimal (i e critical) periods of readiness for all kinds of cognitive acquisi tions children who fail to learn the age appropriate skills at the appropriate time are forever handicapped in acquiring them later Thus both Montessori (Rambusch 1962) and O K Moore (Pines 1963) place particular emphasis in their preschool educational programs on the concept of explosive periods of intellectual growth when unique susceptibility to particular kinds of cognitive stimulation supposedly exists and when optimal readiness for particular kinds of intellectual acquisitions is allegedly present. Seize the opportunity for such learnings at these periods they implore us or be reconciled to the fact that they will be much more difficult or even impos sible at some future date

Serious difficulties however lie in the path of extrapolating the critical periods hypothesis to human cognitive development (Ausubel 1965e) In the first place it has been validated only for infant individuals in infra human species and in relation to those kinds of rapidly developing perceptual motor and social traits that are largely regulated by genic factors In human individuals especially beyond the prenatal period and first year of life environmental determinants of development are more important and the rate of maturation is significantly slower Second it has never been empirically demonstrated that *optimal* readiness exists at particular age periods for specified kinds of *intellectual* activities and that if adequate conditions for growth are not present during those periods no future time is ever as advantageous thereby causing irreparable develop mental deficit

Hence if specific intellectual skills or subject matter content are not acquired at the earliest appearance of readiness this *does not mean* that they cannot be acquired later just as well or even better The same degree of cognitive capacity that establishes readiness at an earlier age would *still* be present at least in *equal* degree at some future date the problem therefore, is not that this degree of maturity disappears or *declines* in some mysterious fashion, but rather that it fails to *grow* at a normal rate in the interim because it is not appropriately exercised The disadvantage of un necessarily postponing such learning tasks thus inheres in the irreparable loss of precious years of opportunity when reasonably economical learning (and the concomitant growth in cognitive capacity) fail to occur simply because these kinds of tasks are not attempted When this happens, the individual, in comparison with equally endowed peers, incurs a deficit in cognitive capacity which limits his current and future rate of intellectual development

THE CUMULATIVE NATURE OF DEVELOPMENTAL DEFICIT This brings us to a second, somewhat more credible, explanation of the possible irreversibility in cognitive development that results from prolonged cultural deprivation (Ausubel, 1965e) We refer to the tendency for existing developmental deficits to become cumulative in nature, since current and future rates of intellectual growth are always conditioned or limited by the attained level of development The child who has an existing deficit in growth incurred from past deprivation is less able to profit developmentally from new and more advanced levels of environmental stimulation Thus, irrespective of the adequacy of all other factors—both internal and external—his deficit tends to increase cumulatively and to lead to permanent retardation

New growth, in other words always proceeds from the existing pheno type, that is, from already actualized capacity rather than from potentialities inherent in the genotype (genic structure) It makes no difference in terms of this limiting influence whether the attained deficiency is attributable to inferior genic endowment or to inadequate environment If, as a result of a consistently deprived environment during the early formative years, potential intellectual endowment is not actualized the attained deficit in functional capacity significantly limits the extent to which later environ mental stimulation even if normal in quantity and quality, can increase the rate of cognitive growth Hence an individual s prior success or failure in developing his intellectual capacities tends to keep his future rate of growth relatively constant Initial failure to acquire adequate language, information processing and problem solving abilities, for example, limits the later growth of cognitive capacities and of cognitive functioning

DIFFERENTIATION OF COGNITIVE FUNCTIONING In addition to the limit ing condition of attained level of development or of existing degree of deficiency, we must consider the further limiting factor of the organism s degree of plasticity or freedom to respond developmentally in a given direction in response to appropriate environmental stimulation (Ausubel, 1965e)

Generally speaking the plasticity of intelligence tends to decrease with increasing age At first intelligence is a relatively undifferentiated capacity that can develop in several different directions But as children grow older, particularly during preadolescence and adolescence, it becomes increasingly more differentiated as shown by the decreasing intercorrelations among the sub-tests of a given intelligence scale (Garrett, Bryan, and Perl, 1935) Another indication of the trend toward the progressive differentiation of abilities is the fact that 10 year-old boys of high socioeconomic status make higher scores than 10 year-old boys of low socioeconomic status on tests of both verbal *and* mechanical ability, but at age 16 are superior only on the verbal tests (Havighurst and Janke, 1944, Janke and Havighurst, 1945) Furthermore the verbal ability scores of boys who drop out of school at the age of 17 tend to decline, whereas their scores on tests of mechanical aptitude continue to improve (Vernon 1948) Thus by the time an individual reaches adolescence differential factors of interest, relative ability, specialization of training[4] motivation success and failure experience, and cultural expectation operate selectively to develop certain potential abilities and to leave others relatively undeveloped Children with particular intellectual disabilities tend to avoid activities involving these disabilities thereby increasing the original deficit (Kirk, 1958)

Once intelligence undergoes definite relative commitment in the various aforementioned channels therefore, the individual manifests less potentiality for growing in areas of minimal development than was the case in the original undifferentiated state Thus for example if because of inadequate stimulation during early and middle childhood genic potentialities for verbal intelligence fail to be adequately actualized other facets of intelligence (quantitative) which are more satisfactorily stimulated become differentially more highly developed At this point therefore, the development of the individual s verbal intelligence is not only limited by his existing deficiency *in the verbal area but also by the fact that much* of his once undifferentiated potentiality for growth in intelligence has already been definitely committed in other directions and hence is no longer available to respond to an enriched verbal environment Thus it is evident that the possibility for complete reversibility of environmentally induced retardation in verbal intelligence decreases as children advance in age This is not to say, of course that later enrichment is entirely to no avail but in our opinion some of this failure in developmental actualization is irreversible and cannot be compensated for later, irrespective of the amount of hyperstimulation that is applied

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[4] Additional evidence of the effect of experience on the differentiation of intelligence comes from studies showing that the intelligence test scores of boys who continue longer in school tend to exceed even twenty years later the test scores of matched controls with less schooling (Lorge 1945) and that gains in IQ scores are much more common in college than in non-college populations (R L Thorndike 1948)

## General Stages of Intellectual Development

General theories of intellectual development, such as those advanced by J Piaget and his collaborators (Inhelder and Piaget, 1958, Piaget, 1950, 1954a), include age level changes in at least four major areas of cognitive functioning, namely, perception, objectivity subjectivity, the structure of ideas or knowledge, and the nature of thinking or problem solving The major focus of our concern in this chapter, however, will be on those devel opmental changes in the individual s cognitive capacities or cognitive processing equipment that affect his learning and retention of meaningful verbal material For example, as children increase in age, they tend to perceive the stimulus world more in general abstract, and categorical terms and less in tangible, time bound, and particularized contexts (Gollin, 1958, Piaget, 1950, 1954a, Serra, 1953), they demonstrate increasing ability to comprehend and manipulate abstract verbal symbols and relationships, and to employ abstract classificatory schemata (Inhelder and Piaget 1958, Piaget, 1950, 1954a, Wallon, 1952), they are better able to understand ideational relationships without the benefit of direct, tangible experience, of concrete imagery, and of empirical exposure to numerous particular instances of a given concept or proposition (Goldman and Levine, 1963, Inhelder and Piaget, 1958, Szuman, 1951, Werner, 1948), they tend more to infer the properties of objects from their class membership rather than from the direct experience of proximate, sensory data (Gollin 1958, Reichard, Schneider, and Rapaport, 1944, Sigel, 1953, Wallon 1952, Wohlwill, 1960b) they are more disposed to use remote and abstract rather than immediate and concrete criterial attributes in classifying phenomena, and to use abstract symbols rather than concrete imagery to represent emerging concepts (M Annett, 1959, Inhelder and Piaget, 1958, Piaget, 1950, 1954a, Werner, 1948), and they acquire an ever increasing repertoire of more inclusive and higher order abstractions (Inhelder and Piaget, 1958 Serra 1953, Welch, 1940 Werner, 1948)

In addition, with increasing age, the cognitive field of children tends to widen both spatially and temporally (H V Baker, 1942, D S Hill, 1930, Probst 1931) Children become more capable of making both broader and more subtle inferences from empirical data (of ' going beyond the information given ) (Bruner, 1964a, Gollin 1958 Kendler and Kendler, 1956), and their cognitive products tend to become both selectively more schematic (Gibson 1953) and less subjective and egocentric in nature (H V Baker, 1942, Piaget, 1928 1929) The older child is more capable of viewing situations from a hypothetical ( as if ) basis or from the standpoint of others (H V Baker, 1942, Piaget, 1928 1929) Finally his attention span increases markedly (Cutteridge 1935 Van Alstyne, 1932)

The most important of the aforementioned changes in intellectual development for educational practice is the gradual shift from concrete to abstract cognitive functioning It defines the principal differences between the respective learning and thinking processes of elementary and secondary school pupils as well as the corresponding differences in pedagogic strategy that they imply This dimension of cognitive development will be considered in detail in a subsequent section and will be related to Piaget s designated stages of intellectual functioning At this point it will be more profitable to consider in general terms both what is meant by a stage of cognitive development and whether the very concept of stage is tenable and useful in understanding age level changes in cognitive capacity and their implications for education

### *The Meaning of Stages*

Piaget s delineation of qualitatively distinct stages of intellectual development has been a powerful stimulus to research in this area as well as a perennial source of theoretical controversy Despite the general cogency and heuristic promise of his formulations however the issue of stages remains unresolved for a number of reasons Some of these reasons unfortunately, inhere in Piaget s unsystematic and faulty methods of conducting his research and reporting his findings[5] In the first place he is almost totally indifferent to problems of sampling reliability and statistical significance He fails to present adequate normative data on age level sex and IQ differences to use uniform experimental procedures for all subjects to designate unambiguous criteria for classifying the responses of his subjects and to determine inter rater reliability In place of statistical analysis of data and customary tests of statistical significance he offers confirmatory illustrations selectively culled from his protocols Second he tends to ignore such obvious and crucial considerations as extent of intersituational generality and relative degree of intra and inter-stage variability in delineating

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[5] *In the past few years the findings* of other investigators (Braine 1959 Case and Collinson 1962 Dodwell 1960 Elkind 1961 Ervin 1960b R J Goldman 1965 Hood 1962 S Jackson 1965 Lovell 1959a b 1961a Lovell and Ogilvie 1960 Lunzer 1960 Mannix 1960 Peel, 1959 Smedslund 1960 1961 Wohlwill 1960a b Yudin and Kates 1963) have on the whole been in general agreement with Piaget s more recent formulations regarding stages of intellectual development They differ from Piaget s findings less in terms of the developmental sequences *identified than in the* specification of different age levels for particular stages in exhibiting greater intra stage variability and in manifesting less inter situational and inter task generality Nevertheless much more rigorous developmental data than have been presented to date especially of a longitudinal nature are required to substantiate Piaget s conclusions

stages of development Third, the cross-sectional observations he uses to measure developmental change (observations on *different* age groups of children) are particularly ill adapted for his purposes The transitional stages and qualitative discontinuities he purports to find can be convincingly demonstrated only by longitudinally extended studies of the *same* children Logical inference is not an adequate substitute for empirical data in naturalistic investigation Finally, he refines, elaborates, and rationalizes the subdivision of his stages to a degree that goes far beyond his data Hence, the psychological plausibility and freshness of the general outlines of his theory tend to become engulfed by a welter of logical gymnastics and abstruse, disorganized speculation

CRITERIA OF DEVELOPMENTAL STAGES The resolution of disagreement with respect to stages of intellectual development is prevented even more by the unwarranted and gratuitous assumptions made by his critics regarding the criteria that *any* designated stage of development must meet, than it is by Piaget's methodological shortcomings Many American psychologists and educators, for example, have been sharply critical of Piaget's designation of stages for the concrete abstract dimension of cognitive development They argue that the transition between these stages occurs gradually rather than abruptly, that variability exists both between different cultures and within a given culture with respect to the age at which the transition takes place, that fluctuations occur over time in the level of cognitive functioning manifested by a given child, that the transition to the formal stage occurs at different ages both for different subject matter fields and for component sub areas within a particular field, and that environmental as well as endogenous factors have demonstrable influence on the rate of cognitive development For all of these reasons, therefore, they deny the validity of Piaget's designated stages

Actually, developmental stages imply nothing more than identifiable sequential phases in an orderly progression of development that are *qualitatively* discriminable from adjacent phases and generally characteristic of most members of a broadly defined age range As long as a given stage occupies the same *sequential position* in all individuals and cultures whenever it occurs it is perfectly compatible with the existence of intra individual, inter individual, and intercultural differences in age level of incidence and in subject matter field It reflects the influence of both genic and environmental determinants, and can occur either gradually or abruptly Hence, all of the aforementioned arguments disputing the legitimacy of Piaget's stages of intellectual development seem quite irrelevant

Although stages of development are qualitatively discontinuous in *process* from one to another, there is no reason why their *manner of achievement* must necessarily be abrupt or saltatory This is particularly true when the factors that bring them into being are operative over many years and are cumulative in their impact Unlike the situation in physical, emotional, and personality development, cognitive development is not marked by the sudden, dramatic appearance of discontinuously new determinants

*It is also unreasonable to insist* that a given stage must always occur at the *same* age in every culture Since rate of development is at least in part, a function of environmental stimulation, the age range in which a stage occurs tends to vary from one culture to another Thus, considering the marked differences between the Swiss and American school systems, it would be remarkable indeed if comparable stages of development took place at the same ages *Similarly, within a given culture,* a particular stage cannot be expected to occur at the same age for all individuals When a particular age level is designated for a given stage, it obviously refers to a *mean* value and implies that a normal range of variability prevails around the mean This variability (Case and Collinson, 1962, R J Goldman, 1965, S Jackson, 1965, Lovell, 1951a) reflects differences in intellectual endowment, experiential background, education, and personality It is hardly surprising therefore that about half of one population of African Bush children never acquired conservation of volume (Greenfield, 1966), that bright children exhibit conservation and combinatorial reasoning earlier than dull children (Goodnow and Bethon 1966), that bright adolescents enter the stage of abstract logical relations earlier than do dull adolescents, that some retarded children never reach the formal stage of logical operations (Jackson 1965), that mental age correlates more highly than does chronological age with attained stage of cognitive development (Goldman, 1965) and that characteristic sex differences (for instance, in mathematical thinking) reflective of differences in cultural expectations and experiential background, are found in degree of cognitive development in different subject matter areas (Elkind 1962)

Thus a certain amount of overlapping among age groups is inevitable A particular stage may be generally characteristic of 5 and 6 year-olds but also typically includes some 4 and 7 year-olds and even some 3 and 8-year-olds Piaget s age levels, like Gesell s, are nothing more than *average* approximations set for purposes of convenience Hence, to attack the concept of developmental stages on the grounds that a given stage includes children of varying ages, instead of taking place at the precise age designated by Piaget is simply to demolish a straw man

One also cannot expect *complete* consistency and generality of stage behavior within an individual from one week *or month to another,* and from one subject matter or level of difficulty to another Some overlapping and specificity are inevitable whenever development is determined by multiple, variable factors A *particular 12 year-old may use formal logical* operations in his science course in October but may revert for no apparent reason to a concrete level of cognitive functioning in November or even several years later when confronted with an extremely difficult and unfamiliar problem in the same field

Furthermore he may characteristically continue to function at a concrete level for another year or two in social studies and literature Since transitions to new stages do not occur instantaneously but over a period of time fluctuations between stages are common until the newly emerging stage is consolidated In addition because of intrinsic differences in level of subject matter difficulty and because of intra and inter individual differences in ability profiles and experiential background it is hardly surprising that transitions from one stage to another do not occur simultaneously in all subject matter areas and sub areas Abstract thinking for example generally emerges earlier in science than in social studies because children have more experience manipulating ideas about mass time and space than about government social institutions and historical events However in some children depending on their special abilities and experience the reverse may be true In any developmental process where experiential factors are crucial age by itself or degree of brightness is generally less important than degree of relevant experience (Deutsche 1937 Dodwell 1960 1961 Elkind 1961 Vinacke 1951) Finally stages of development are always referable to a given range of difficulty and familiarity of the problem area Beyond this range individuals commonly revert (regress) to a former stage of development (Case and Collinson 1962)

Neither is the concept of developmental stages invalidated by the demonstration that they are susceptible to environmental influence It is erroneous to believe that stages of intellectual development are exclusively the products of internal ripening and hence that they primarily reflect the influence of endogenous factors Gesell s embryological model of development has little applicability to human development beyond the first year of life when environmental factors become increasingly more important determinants of variability in developmental outcomes In fact as the educational system improves we can confidently look forward to the earlier mean emergence of the various stages of cognitive development This much is clearly evident from data indicating that schooled African Bush children acquire conservation of volume earlier and give fewer perceptual (as opposed to conceptual) reasons for conservation or nonconservation than do their unschooled counterparts (Greenfield 1966) Urban living seems to have some of the same effect as schooling in this regard inasmuch as unschooled Hong Kong children do as well as schooled Hong Kong children on conservation tasks but not as well on a task of combinatorial reasoning (Goodnow and Bethon 1966)

### *Quantitative and Qualitative Changes in Intellectual Development*

Still another reason for confusion and conflict about the problem of stages in intellectual development is the tendency to adopt an all-or none position regarding the existence of such stages Actually, the evidence suggests that some aspects or *dimensions of intellectual development* are characterized by quantitative or continuous change, whereas others are characterized by qualitative or discontinuous change Hence, if the issue is no longer approached from the standpoint of an all-or none proposition, *much truth can be found on both sides*

*Some* types of logical operations (equivalence, eliminative) and approaches to problem solving (trial and error versus insightful) appear to differ in degree rather than in kind from one age level to another[6] The evidence indicates that these kinds of logical operations and problem solving approaches are employed at all age levels, and differ principally in degree or complexity at different ages (Burt, 1919, Long and Welch, 1941a, Welch and Long 1943) As N L Munn (1954) points out, the age differences are partly attributable to disparity in previous experience, motivation, and neuromuscular coordination Perhaps an even more important source of these age level differences, however, is the child s growing ability to generalize and use abstract symbols Both trial and-error and insightful problem solving for example, are found in preschool children, elementary school children adolescents and adults the choice between these two approaches at all ages depends on the inherent difficulty of the problem on the individual s prior background of experience, and on the problem s amenability to logical analysis It is true that insightful approaches tend to increase with age *but* only because *increasing* ability to generalize and use abstract symbols permits a more hypothesis-oriented approach

Two dimensions of intellectual development characterized by gradually occurring *qualitative* change on the other hand, are the transition from subjective to objective thought and the *transition from concrete to abstract*

[6] It is important not to confuse *quantitative* changes in these *simple* logical operations from one age level to another with those changes in logical operations that *are* reflective of *qualitatively* different stages along the concrete abstract dimension of cognitive development Thus the more significant logical operations (for instance reversibility ) imply a capability to understand and meaningfully manipulate relationships between secondary abstractions—a capability that is not present in the preoperational (logically nonoperational ) child Similarly whether or not a given individual is dependent *on concrete-empirical* props in performing *logical* operations determines whether he is in the concrete or abstract stage of logical operations

cognitive operations Acquisition of the ability to separate objective reality from subjective needs and preferences results in the gradual disappearance of autistic animistic anthropomorphic magical absolutistic and nominalistic thinking (Piaget 1928 1929 1932) Reference has already been made to studies supporting Piaget s findings (Inhelder and Piaget 1958 Piaget 1950 1954b 1957b) regarding the transition from concrete to abstract thought These findings will be discussed in greater detail below and in Chapter 16

## *General Implications of Developmental Stages for Education*

Knowledge of the timetable of intellectual development makes possible for the first time the scientific as opposed to the arbitrary or traditional grade placement of subject matter Detailed knowledge of the development for example of number and spatial concepts of ideas regarding causality and of appreciation of scientific method would be helpful indeed in the grade placement of such subjects as mathematics and science Even more specifically K Lovell (1961b) suggests a parallelism between basic principles of number theory (associativity commutativity) and the particular cognitive operations ( groupings ) elementary school children use in intellectual functioning Insight into the course of intellectual development according to H Aebli (1951) could also enable teachers both (a) to guard against (and hence discourage) certain kinds of congitive immaturity (subjectivity egocentricity animism anthropomorphism nominalism teleological reasoning ideas of single causality focusing on just a single aspect of a problem) and (b) to provide experience facilitating the transition from lower to higher stages of intellectual functioning (concrete to abstract logical operations)

Reference has already been made to the possibility of the earlier *intuitive* introduction into the curriculum of more advanced subject matter such as algebra geometry set theory quadratic equations physics and so forth In certain selected instances where *genuine readiness* actually exists it may be desirable for children to acquire prior intuitive understanding of such material—if for no other reason than to reduce the unfamiliarity of the ideas in question when they are introduced later and to discourage the possibility of rote verbal learning in high school and college Such intuitively learned content may serve as anchoring ideas or as general background for the later learning of the same content at a higher level of abstraction thereby increasing its potential meaningfulness J S Bruner (1960) and G C Finlay (1960) refer to this philosophy of curriculum organization as the spiral curriculum R Karplus (1962a) argues that unless children are taught scientific principles and methodology on an intuitive basis in elementary school they spontaneously acquire and later must un learn various misconceptions derived from spontaneous or folk lore models of physical and biological causality In any case many considerations are involved in deciding which *particular* kinds of intuitively oriented subject matter lying within elementary school children s scope of adequate readiness *are suitable for such a curriculum*

## The Concrete Abstract Dimension of *Cognitive Development*[7]

The concrete abstract dimension of intellectual development may be divided into three qualitatively distinct developmental stages—the pre *operational stage the stage of concrete logical operations* and the stage of abstract logical operations—which cover respectively the preschool elementary school and adolescent adult periods of development

### *Pre operational Stage*

During the pre-operational stage the child is capable of acquiring *primary* abstractions (concepts) and of understanding using and mean ingfully manipulating for problem solving purposes both primary abstractions and the relations between them *Primary concepts* are those concepts whose meanings a given individual originally learns in relation to genuine concrete empirical experience that is those of his concepts whose criterial attributes whether discovered or presented yield generic meanings during learning when they (the attributes) are *first* explicitly related to the ex amplars from which they are derived *before* being related alone to his cognitive structure Once acquired of course, the pre-operational child can understand and use concept meanings apart from their particular exemplars and he can also understand and manipulate in problem solving operations relationships between these primary abstractions namely propositions composed of such abstractions

*But the fact that he is limited to the acquisition of* primary abstractions and to the understanding and manipulation of such abstractions and the relationships between them the fact that he cannot similarly handle *secondary* abstractions and relationships between secondary abstractions obviously imposes severe constraints *on the level of abstraction at which he*

[7] The following description of this aspect of cognitive development uses the same stage names but is really quite different from the account given by Piaget and Inhelder (Inhelder and Piaget, 1958 Piaget 1950 1951b 1957b) The term abstract is used synonymously with Piaget s term formal

operates *Secondary concepts* are those concepts whose meanings a given individual does *not* learn in relation to genuine concrete-empirical experience, *that is those of his concepts whose criterial attributes yield generic meanings* during learning when they (the attributes) are related to his cognitive structure *without* being first explicitly related to the particular exemplars from which they are derived The pre-operational childs understanding and manipulation of abstract concepts and propositions take place at a level of abstraction that is only slightly removed from the intimate participation of concrete-empirical experience in the acquisition of his primary concepts themselves

One important manifestation of this constraint is that many significant logical operations (in fact all those, such as reversibility that really make him logically operational ) imply a capability to understand and manipulate relationships between secondary abstractions Thus because he cannot perform the logical operation of reversibility he cannot (unlike the concrete or abstract operational child) grasp the idea of conservation for example he does not conserve mass—appreciate that mass remains constant even though its shape changes because he does not realize that deformations of shape are reversible or that a loss in one dimension is compensated for by a gain in another [8] Another consequence of his inability to perform true logical operations and of the related fact that the meanings of many of his primary concepts (particularly those of familiar perceptible objects and events) are little more than idealized images embodying appropriate criterial attributes is that problem solving at this stage involves much overt manipulation of objects and internal manipulation of near images

### *Concrete Operational Stage*

During the concrete operational stage the child is capable of acquiring secondary abstractions and of understanding using and meaningfully manipulating both *secondary* abstractions and the relations between them But both in acquiring secondary abstractions and in understanding and manipulating relations between them he differs from the abstract operational individual in using *concrete empirical props* In conformity with the definition of a secondary concept given above he does *not* learn the meaning of a concept by *first* relating its criterial attributes to the particular exemplars

[8] Piagets explanation of conservation is not that logical operations such as reversibility imply a capability to understand or manipulate relationships between secondary abstractions (a capability whose existence he denies at the stage of concrete logical operations) but rather that logical operations (which he defines as internalized actions ) first exist by definition at the concrete operational stage

from which they are derived *before* relating them to his cognitive structure he learns its meaning rather by relating the criterial attributes *directly* to his cognitive structure—but typically with the benefit of concrete-empirical props namely exemplars of the various *attributes* The use of such props in concept acquisition implies a more abstract process of learning than the actual use of genuine concrete-empirical experience itself because (a) The exemplars of attributes are examples of the *abstracted* properties *of a concept*—not particular instances of the concept (b) A *single* example of an attribute suffices as a prop as opposed to the multiple exemplars of the concept that are given in concrete empirical experience and (c) The prop serves mainly as a crutch in relating the criterial attribute to cognitive structure rather than as the concrete-empirical matrix from which either the criterial attribute itself is derived or in relation to which it derives its potential meaningfulness

For example while the concept of work is being learned as a primary concept the pre-operational child may eventually hypothesize such attributes as activity necessary and useful as criterial by abstracting them from farming fixing cars keeping house nursing and so forth or he may be given these attributes In either case however he tests each of the attributes against each of the exemplars before relating them to his cognitive structure *If in elementary school he learns the concept of work as a secondary* concept he is given its attributes in definitional form and may use an exemplar for one or more of the attributes in relating them to his cognitive structure Finally as a high school student in the abstract operational stage he relates the criterial attributes directly to his cognitive structure without props and if he does not know the meaning of a given attribute it too need only be defined

Once secondary concepts are acquired the concrete operational child is no longer dependent on props in understanding or using their meanings Understanding *relationships between secondary abstractions* (or meaningfully manipulating these relationships for problem solving purposes) however *is quite another matter* In this kind of learning task he is dependent upon recent or concurrent concrete-empirical props consisting of a particular exemplar for each of the abstractions in the relationship when such props are not available he finds abstract propositions unrelatable to cognitive structure and hence devoid of meaning This dependence upon concrete-empirical props self-evidently limits the generality and abstractness of his attempts meaningfully to grasp and manipulate relationships between abstractions he can acquire only those relational understandings and perform only those relational problem solving operations that do not go beyond the somewhat particularized representation of reality implicit in his use of these props Thus where complex propositions are involved he is largely restricted to an *intuitive or semi abstract level of cognitive functioning a* level that falls far short of the clarity, precision, explicitness, and generality associated with the more advanced abstract stage of intellectual development

During the elementary school years therefore, abstract verbal propositions (propositions consisting of relationships between secondary abstractions) that are presented on a purely expository basis are too remotely removed from *concrete-empirical experience to be relatable to cognitive* structure This does not mean, however, that autonomous discovery is required before such propositions can be meaningfully learned, as long as concrete empirical props are made an integral part of the learning situation, they (the propositions) are eminently learnable Concrete-empirical props also need not necessarily be nonverbal or tangible (objects pictures) Concrete and 'nonrepresentational are not synonymous, words that represent particular exemplars or attributes of a concept are very adequate concrete empirical props in learning abstract propositions and secondary concepts respectively

With the advent of logical operations and particularly of the operation of reversibility, the concrete operational child exhibits conservation (Eifermann and Etzion 1964 Piaget, 1950 1952a Smedslund, 1962) in his thinking and understanding This phenomenon, however, does not emerge in unitary fashion over all kinds of problem solving tasks and materials In order of emergence conservation of mass weight number, and volume are acquired (Piaget, 1950 Uzgaris 1964) Because he can perform these operations and because the meanings of his concepts are more abstract in nature, problem solving involves less overt manipulation of objects and internal manipulation of images

It is important to realize that just because the concrete operational child uses concrete empirical props in understanding and thinking about relationships between abstractions this stage of intellectual development is not really concrete in the sense that objects or *concrete images* of objects are relationally manipulated in meaningful reception or discovery learning Contrary to Piaget s contention that the child at this stage conducts logical operations on concrete objects and that his thought processes are closely *tied to his concrete experience the evidence suggests that* he essentially understands and manipulates relations between the verbal representations of secondary abstractions The concreteness of this stage inheres rather, in the fact that secondary abstractions and the relationships between them can be understood and meaningfully manipulated *only* with the aid of current or recent concrete empirical props Logical operations are therefore constrained in the generality and abstractness of their implications by the particularity of the props in question, unlike the situation in the later stage of abstract logical operations they do not involve logical transformations of all possible and hypothetical relationships between general abstract vari ables.[9] Nevertheless they are more closely related in level of abstraction to the following than to the preceding stage of cognitive development and represent a very significant advance over the latter. It also appears that Piaget overstates his case and gives children too little credit when he does not differentiate between primary and secondary abstractions in asserting that only in the final stage can children understand and manipulate relationships between abstractions: as far as relationships between primary abstractions are concerned, this capability is evident without props in the concrete operational and even in the pre-operational stage.

### *Abstract Logical Stage*

Beginning in the junior high school period, the pupil becomes increasingly less dependent upon the availability of concrete-empirical props in meaningfully relating abstract relationships to cognitive structure. Eventually he no longer needs them at all in understanding and meaningfully manipulating relationships between abstractions. He then assimilates abstract propositions and solves abstract problems in terms of all-inclusive hypothetical possibilities rather than in terms of these possibilities as constrained by their reference to "the here and now." In other words, he attains full conceptual and propositional generality. "Instead of just coordinating facts about the actual world, hypothetico-deductive reasoning draws out the implications of possible statements and thus gives rise to a unique synthesis of the possible and the necessary" (Piaget, 1957a, p. 19).

B. Inhelder and J. Piaget (1958) present considerable evidence indicating that "formal" (abstract) operations appear slightly before the onset of adolescence. On the whole their findings are corroborated by other investigators (R. J. Goldman, 1965; S. Jackson, 1965; Lovell, 1961a; Yudin, 1966; Yudin and Kates, 1963). Lovell's subjects attained this stage of development somewhat later than Inhelder and Piaget's, and D. Case and J. M. Collinson's (1962) somewhat earlier. Both R. J. Goldman and S. Jackson reported greater age variability, and Jackson less inter-task generality, than did In-

[9] R. Brown (1958b) argues that the cognitive processes of adults are more abstract than those of children only in the sense that they manifest more discriminative generalization—that children actually exhibit more simple stimulus generalization than do adults (i.e., generalization not requiring prior discriminative analysis). Hence he claims that adults do not really use a wider range of abstract concepts in their thinking, but merely employ a more highly differentiated repertoire of subcategories within existing categories. Simple stimulus generalization, however, can hardly be considered a form of abstract thinking that reflects the use of abstract concepts. Thus it seems more plausible to believe that adults also characteristically use a greater number of *generic categories* than do children, as well as more differentiated subcategories.

helder and Piaget in the development of formal thinking None of these findings, however, detract from the essential validity of Piaget's conclusion that for the first time the child entering this stage of cognitive development thinks in terms of all inclusive hypothetical possibilities (instead of the 'here and now )

Eventually, after sufficient gradual change in this direction, a qualitatively new capacity emerges the intellectually mature individual becomes capable of understanding and manipulating relationships between abstractions without any reference whatsoever to concrete-empirical reality Instead of reasoning directly from a particular set of data, he uses indirect, second order logical operations for structuring the data, instead of merely grouping data into classes or arranging them serially in terms of a given variable, he formulates and tests hypotheses based on all *possible* combinations of variables (see also Grodskaya, 1962) Since his logical operations are performed without props on abstract verbal prepositions, he can go beyond the operations that follow immediately from concrete-empirical reality and deal with all possible or hypothetical relations between ideas He can now transcend the previously achieved level of intuitive thought and understanding and formulate general laws relating, to each other, general variables that are divorced from the concrete empirical data at hand His concepts and generalizations, therefore, tend increasingly to be second-order constructs derived from relationships between previously established verbal abstractions that are already one step removed from the data itself And, since he is freed from dependence on nonabstract contact with empirical data in independently *discovering* meaningful new concepts and generalizations, he is obviously also liberated from this same dependence in the much less rigorous task of merely *apprehending* these constructs meaningfully when they are verbally presented to him

Careful analysis of the experiments performed by Inhelder and Piaget, and by the other investigators cited above as well as Lunzer s (1965), does not substantiate their view that the *distinctive* feature of formal or abstract (as opposed to concrete) operations is that the older child is able to deal internally with ideas about ideas or to perform second order operations The younger ( concrete operational ) child can *also* do these things, as shown by the studies of Case and Collinson (1962) and S A Hill (1961) The latter demonstrated for example, that most children aged 6 to 8 can easily draw correct inferences from hypothetical premises involving abstract relationships It is rather the preadolescent s and adolescent s ability verbally to manipulate relationships between ideas *in the absence of recently prior or concurrently available concrete empirical* props that is the distinctive attribute of formal operations (Hill s subjects after all, were given logical problems that were invariably stated in terms of *particular* instances) This new capability emerging at age 11 and beyond invests propositional thought with a genuinely abstract and nonintuitive quality Ideas about ideas now achieve a truly general status that is freed from any dependence whatsoever on particular instances and concrete experience It is for this reason that thinking becomes hypothetico-deductive in nature that is refers to all possible relationships between variables rather than to relationships constrained by reference to particular instances

### *Determinants of Change*

It is evident from the foregoing account of developmental stages along the concrete abstract dimension of cognitive functioning that there is a developmental aspect to meaningful learning At successive stages along this dimension the individual is able meaningfully to relate increasingly more abstract materials to his cognitive structure *In part this is attributable* to developmental changes in the content of cognitive structure itself— changes that either make the same logically meaningful material which is not potentially meaningful at an earlier stage potentially meaningful at a later stage or else enable him to generate more abstract and complex problem-solving propositions In part also this is attributable to growth in whatever cognitive processes are involved in nonarbitrarily and substantively relating learning tasks to established ideas in cognitive structure and in generating new problem-solving propositions

Thus it is hypothesized that the combined influence of three concomitant and mutually supportive developmental trends accounts for the transition from concrete to abstract cognitive functioning In the first place the developing individual gradually acquires a working vocabulary of transactional or mediating terms (for example conditional conjunctions qualifying adjectives) that makes possible the more efficient juxtaposition and combination of different relatable abstractions into potentially meaningful propositions and their subsequent relationship to established ideas in cognitive structure Second he can relate these latter propositions more readily to cognitive structure and hence render them more meaningful because of his growing fund of stable higher-order concepts and principles encompassed by and made available within that structure D H Russell and I Q Saadeh (1962) for example found that between the sixth and ninth grades children s use of concrete definitions decreases and their use of abstract and functional definitions correspondingly increases A sufficient body of abstract concepts that are clear and stable is obviously necessary before one can hope efficiently to manipulate relationships between them so as to generate meaningful general propositions The possession of a working body of inclusive concepts also makes possible the formulation of more general statements of relationship that are less tied to specific instances greater integration of related ideas and different aspects of the same problem the elaboration of more precise distinctions and finer differentiations and less dependence on complete concrete-empirical data in reaching warranted inferences

Finally it seems reasonable to suppose that after many years of practice in understanding and meaningfully manipulating relationships between abstractions *with* the aid of concrete-empirical props the older child gradually develops greater facility in performing these operations so that eventually (after acquiring the necessary transactional and higher-order concepts) he can perform the same operations just as effectively *without* relying on these props The same sequence of events is seen in acquiring many other neuromuscular and cognitive skills—walking without holding on bicycling without hands speaking a foreign language without internal translation from one s mother tongue transmitting Morse code in sentences rather than in word or letter units

Piaget and Inhelder (Inhelder and Piaget 1958 Piaget 1950 1953 1957b) largely embrace a maturational position in explaining how developmental transition is effected during the various stages of intellectual development Their view of maturation however which they call equilibration is inclusive of both internal (genic) factors and *incidental* learning It is therefore closer to the empirical concept of maturation than it is to A Gesell s notion of maturation as a process of internal ripening According to J Smedslund conservation of weight is acquired by a process of internal equilibration independently of external reinforcement By equilibration is meant a change in the direction of increasing stability consistency and completeness of behavioral structures Conflicts are eliminated and gaps are closed [Equilibration] is heavily dependent on activity and experience [but such experience] is not assumed to act through external reinforcements but by a process of mutual influence of the child s activities on each other (Smedslund 1961)

Thus according to Piaget maturation (genic factors and general aspects of incidental experience) accounts for the universality of the sequential stages and the order in which they occur whereas variability in the kind of *incidental learning experience accounts for interindividual intraindividual* and intercultural differences in the age at which stages occur and in the content area in which they are manifested Piaget and his followers (for instance Smedslund 1961) deny that specific learning experience or training (practice) particularly of a verbal nature or for that matter education generally has any significant influence on the emergence of stages of intellectual development We shall return to this problem later in another context in considering whether training can accelerate stages in cognitive development

Both general and specific motivational explanations (Inhelder and Piaget 1958) have been advanced to account for the transition from the concrete operational to the abstract operational stage Desire to obtain greater meaning out of experience is not a convincing explanation since this desire does not arise suddenly or uniquely at adolescence Furthermore although motivation may energize and facilitate cognitive change it cannot convincingly explain either its occurrence or direction Desire to identify with and participate in the adult world has more specific relevance for this age period but again no amount of motivation would suffice to effect the change in question in the absence of the necessary genic potentialities and supportive experience

### *General and Specific Aspects of the Transition*

We have already rejected complete generality over subject matter areas and levels of difficulty as a legitimate criterion of a developmental stage Too much unevenness exists in any individual s experiential background and pattern of abilities for the transition from concrete to abstract functioning to occur *simultaneously* in all areas A stage of development also is always referable to a typical range of difficulty and familiarity of the problem at hand beyond this range regression to an earlier stage of development commonly occurs It is apparent therefore that the transition from concrete to abstract cognitive functioning takes place *specifically* in each subject matter area and presupposes a certain necessary amount of sophistication in each of the areas involved This specificity however does not invalidate the existence of qualitatively distinct stages of development It is still possible to designate an individual s *over all* developmental status as concrete or abstract on the basis of an estimate of his *characteristic or predominant* mode of cognitive functioning M A Stone (1966) found that beginning with junior high school age the generality of abstract cognitive functioning increases with age (that is gradually encompasses more subject matter fields in older pupils) This trend was evidenced by successively higher intercorrelations with increasing age among learning scores on tests of ability to learn abstract verbal material in different disciplines

This distinction between specific and general aspects of developmental status is important for two reasons First the individual necessarily continues to undergo the same transition from concrete to abstract cognitive functioning in each *new* subject matter area he encounters—even *after* he reaches the abstract stage of development on an over all basis Second once he attains this latter general stage however the transition to abstract cognitive functioning in unfamiliar new subject matter fields takes place much more readily than is the case at earlier phases of *the transition* For example a cognitively mature adult who has never studied astronomy is not completely in the same developmental position as an 11 or 12 year-old with respect to the concrete abstract dimension when both begin an introductory course in astronomy

Thus even though an adolescent or adult characteristically functions at the abstract level of cognitive development he tends *initially* to function at a concrete intuitive level when he is first introduced to a wholly unfamiliar subject matter field But since he is able to draw on various transferable elements of his more *general* ability to function abstractly he passes through the concrete stage of functioning in this particular subject matter area much more rapidly than would be the case were he first emerging from the stage of concrete logical operations These facilitating transferable elements presumably include transactional terms higher order concepts and ability *directly* to understand and manipulate relationships between abstractions (without the benefit of concrete empirical props) which although acquired in other specific subject matter contexts are generally applicable to new learning situations (see below)

In other words growth in cognitive development always proceeds at two levels concomitantly—specific and general Experience in learning *any* subject matter produces general as well as specific *developmental* changes in cognitive capacity in addition to specific changes in subject matter readiness As a result of experience in studying a given discipline pupils not only learn particular ideas that facilitate the later learning of other particular ideas but also acquire greater capacity meaningfully to process more abstract material of *any* nature in that particular discipline and other disciplines as well General cognitive development in any given dimension therefore occurs with increasing age and education and is independent of particular kinds of subject matter experience It is these general and transferable aspects of changed cognitive capacity occurring in the transition from concrete to abstract intellectual functioning in any particular discipline that facilitate the same transition in *any* new subject matter area Thus the cognitively mature adolescent confronted with a learning or problem solving task in an unfamiliar discipline does not have the benefit of *specific* cognitive changes along the concrete abstract dimension resulting from past experience with that subject matter area In this sense he is no better off than the immature child who has not undergone the over all transition from the concrete to the abstract stage he has to make this transition anew in the unfamiliar area But he makes the transition more easily because of the *general* cognitive changes that have occurred along this dimension and which are transferable to the particular new subject matter field

Hence in contrast to the cognitively immature child who continues to use concrete empirical props in relating abstractions to each other as long as he is in the concrete stage the adolescent uses the props only initially—to develop the necessary higher order abstractions in the new discipline—

and then proceeds to dispense with props entirely in acquiring additional abstractions His dependence on concrete-empirical props, in other words is temporary and reflective of circumscribed cognitive immaturity in particular subject matter fields rather than reflective of an over all concrete level of cognitive functioning

## Educational Implications of the Concrete, Intuitive Level of Cognitive Functioning

### *Dependence on Concrete Empirical Props*

The elementary school child is completely dependent upon current or recent concrete-empirical props in understanding or meaningfully manipulating *relational* propositions consisting of secondary abstractions He tends to appreciate relationships between such abstractions intuitively—as rather immediate logical extensions of his own personal experience—rather than in the truly abstract sense of relationships between general variables Hence general laws and methodological canons of science in their own right have little meaning and intellectual appeal for him they make sense only insofar as they are relatable to more tangible types of experience Utility is a major example of this type of experience but is certainly not the only possible example

As far as elementary school children are concerned therefore, one cannot hope to reduce science to first principles and basic abstract laws [10] At the very best one can strive for a semi abstract intuitive grasp of these laws on a descriptive or perhaps semi analytic level that is somewhat tied to particularized experience On the methodological side abstract principles of scientific inquiry and strategy also have much less meaning for children than a purely concrete-empirical explanation of how it is possible for man kind to know the facts and generalizations under discussion [11]

The developmental characteristics of the elementary school child s cognitive functioning do not require however that we restrict the pedagogic use of these years to teaching the fundamental intellectual skills His cognitive equipment is certainly adequate enough for acquiring an intuitive grasp of many concepts in the basic disciplines Thus for example the psycho-

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[10] Both R Karplus (1962a) and M H Shamos (1961) deplore the emphasis in elementary science education upon the practical utilitarian aspects of science and the attempt to relate science primarily to everyday experience They advocate instead stress upon the concepts and methods of science

[11] J M Atkin and S P Wyatt (1961) emphasize the how we know aspects of astronomy using didactic exposition and simple exercises and demonstrations

logical argument for teaching science in the elementary school is extremely convincing (Karplus 1962a) First it is well known that young children spontaneously acquire many animistic and subjectivistic conceptions about the physical and biological universe (Piaget 1932) These notions also tend to persist and often compete with more mature conceptions especially when not counteracted by early scientific training Second without early and satisfactory instruction in science it is difficult for children both to assimilate positive interests in and attitudes toward the scientific enterprise and to avoid being negatively conditioned to scientific subject matter Third since elementary school pupils can easily acquire an intuitive grasp of many scientific concepts failure to provide suitable opportunities for them to do so not only wastes available readiness for such learning but also wastes valuable time in junior and senior high school that could be used for more advanced instruction in science Finally as pointed out above these intuitive ideas constitute a foundation for the later assimilation of more abstract general and precise versions of the same content thereby increasing their potential meaningfulness and preventing rote learning

Thus the concept of a spiral curriculum mentioned earlier is eminently sound provided that an attempt is *not* made to teach at an intuitive level reduced versions of *anything* or *everything* that is presented later at a more abstract level the use of concrete empirical props after all does not make *every* secondary abstraction and *every* proposition composed of secondary abstractions intuitively understandable irrespective of their inherent complexity and degree of abstractness and irrespective of the learner s antecedent subject matter experience The content of an appropriate intuitively oriented curriculum should therefore include only such intuitively based materials for which the elementary school pupil exhibits adequate developmental and subject matter readiness and even with respect to these materials much selectivity is required in choosing the *particular* intuitive content that will be most useful for later subject matter learning

In any case the suggestion that sciences be studied in the order of their phenomenological complexity—that one start with the basic concepts of physics and chemistry before tackling the complex phenomena of biology and geology (Shamos 1961) although logically sound is psychologically unfeasible More important pedagogically than the logical structure of knowledge is the pupil s intellectual readiness to handle different kinds of subject matter and from the standpoint of relevant experience and readiness the phenomenologically simple laws of physics are far more abstract and difficult than the phenomenologically complex laws of biology and geology which are so much closer to everyday experience This is not to deny the possibility that some aspects of physics might be profitably introduced in the elementary school curriculum However before this could be done in the rigorous fashion [physics] deserves the teaching of elementary school mathematics would first have to be sufficiently improved to make possible a more functional intuitive understanding of the quantitative relationships that figure so prominently in the physical sciences (Shamos 1961)

The teacher s task of translating ideas into language that is compatible with the elementary school child s cognitive capacities and level of cognitive functioning is difficult indeed First in teaching others his natural tendency is to adopt the same level of discourse he himself characteristically uses in learning new ideas Second once he has acquired difficult concepts he tends to regard them as self-evident and to forget both the limiting developmental factors involved in the learning process as well as the numerous misconceptions and ambiguities he had to overcome in the course of learning After he has mastered a particular discipline he tends to think of its structure only in terms of the logical relationships between component ideas forgetting the psychological process of progressive differentiation involved in acquiring any new body of knowledge Lastly because of his more sophisticated and highly differentiated cognitive structure he is very aware of the various subtleties connotations ramifications and qualifications connected with even simple ideas and often fails to realize that the introduction of such complications only confuses his pupils

Although the *preschool* child is restricted to relatively nonabstract (primary) concepts in the learning of most propositions it is not necessary that all relational learning during this period take place on a nonverbal problem solving or completely autonomous self-discovery basis in order to be meaningful Simple derivative propositions involving primary concepts can certainly be directly apprehended without the use of particular exemplars and simple correlative superordinate and combinatorial propositions can also be learned on a reception basis—particularly if specific verbal exemplars of the concepts involved or an opportunity for manipulation of objects or concrete images is provided Autonomous self-discovery of the proposition to be learned might conceivably enhance current learning and provide additional motivation for future learning but is certainly not indispensable for meaningful reception learning

Neither does the *elementary school* child s dependence on concrete empirical props for the understanding of more abstract propositions require that all or even most teaching be conducted on an inductive problem solving (discovery) and nonverbal basis The only essential condition during this period for the reception learning of propositions embodying secondary concepts is the *availability of specific* exemplars of the concepts in question and such exemplars may be purely verbal in nature Didactic exposition with such verbal props can easily be combined with other concrete-empirical props in the form of demonstrations and usually suffices for the presentation of most subject matter that is neither excessively complex nor excessively unfamiliar In these latter instances it may be desirable to enhance the understanding achieved through verbal exposition by subjecting the pupil to Socratic questioning or by providing him with a semi autonomous type of problem solving experience (guided discovery) in which discovery itself is accelerated by the arrangement of materials and by the use of prompts, hints, and Socratic questioning

It is a serious mistake, therefore, to believe that meaningful intuitive learning during the stage of concrete logical operations must necessarily be restricted to nonverbal problem solving Verbally expressed relationships between abstract ideas can be adequately comprehended when presented didactically—although in a somewhat particularized sense—as long as con crete-empirical props (verbal or nonverbal) are available Hence, con currently with providing elementary school children with "particularly informative and suggestive experience as a base for their [more difficult] abstractions, one must provide them "with a conceptual framework that permits them to perceive the phenomena in a meaningful way and to inte grate their inferences into generalizations of lasting value" (Karplus, 1962a, pp 243 244)

### *Specificity or Generality of Intuitive Learnings*

In accordance with their conception of intuitive learning during the concrete stage of logical operations, J S Bruner and B Inhelder (Bruner, 1960) propose an intuitive elementary school curriculum that is character ized by extreme generality and separation from the actual content of the various disciplines It is oriented toward certain universal and recurrent principles of science which when learned once in general form, are supposedly applicable to the more specific problems of the particular sciences— categorization and its uses the unit of measure and its development, the indirectness of information in science and the need for operational defini tion of ideas, the attitude that things are connected and not isolated the idea of multiple determination of events in the physical and social world (Bruner, 1960, pp 26 27) Inhelder suggests that we

> devote the first two years of school to a series of exercises in manipulating classifying and ordering objects in ways that highlight basic operations of logical addi tion multiplication inclusion serial ordering and the like For surely these logical operations are the basis of more specific operations and concepts of all mathematics and science It may indeed be the case that such an early science and mathematics precurriculum might go a long way toward building up in the child the kind of intuitive and more inductive understanding that could be given embodiment later in formal courses in mathematics and science The effects of such an approach would be we think to put more continuity into science and mathematics and also to give the child a much better and firmer comprehension of the concepts

which until he has this early foundation he will mouth later without being able to use them in any effective sense (Bruner, 1960, p 46)

In the first place, it is questionable whether general content free logical operations and principles of science have any applicability to the understanding of ideas in a *particular* science The philosophy and fundamental concepts of a given discipline are largely shaped by its unique content, history, and methodology Scientific method and theory are not readily transferable across different disciplines Hence, principles that hold true for a wide range of sciences are more likely to constitute basic postulates of a general philosophy of science than to have relevance for the substantive content or methodology of any particular science Second, general principles of scientific inquiry cannot, by definition be learned on a purely abstract and general basis at this stage of development They also consist of complex, higher-order abstractions that the elementary school child would find exceedingly difficult, if not impossible, to relate meaningfully to his cognitive structure, even on an intuitive basis, with the aid of concrete-empirical props, and even if he could do so, it is questionable what value such intuitive understandings could have since it is precisely because of their *generality* and *nonintuitive* properties that interdisciplinary principles of scientific inquiry are presumed to be transferable to other disciplines and heuristically valuable Finally, as we shall see later in another context, although the content organization objectives and methods of the elementary school curriculum must obviously be adapted to the cognitive capacities of pupils, the curriculum must still systematically come to grips with the actual *substantive* content and specific methodology of each of the various disciplines

### *Can Any Subject Be Taught Intuitively at Any Age Level?*

By suitably adapting methods of teaching to the child s level of cognitive functioning J S Bruner believes that it is possible to teach preschool and elementary school children any subject that can be taught to adolescent and adult students

> At each stage of development the child has a characteristic way of viewing the world and explaining it to himself The task of teaching a subject to a child at any particular age is one of representing the structure of that subject in terms of the child s way of viewing things The task can be thought of as one of translation (p 33) If one respects the ways of thought of the growing child if one is courteous enough to translate material into his logical forms, and challenging enough to tempt him to advance then it is possible to introduce him at any early age to the ideas and styles that in later years make an educated man (p 51)
> Any idea can be represented honestly and usefully in the thought forms of children

of school age and these first representations can later be made more powerful and precise the more easily by virtue of this early learning (p 33) [Actually] any subject can be taught effectively in some intellectually honest form to any child at any stage of development (Bruner 1960 p 33)

It is quite possible, of course, that prior intuitive understanding of certain concepts and principles during childhood can facilitate their learning and stabilize their retention when they are taught at a more formal, abstract level during adolescence—even if the child s readiness for the earlier learnings is not adequate However, confirmatory empirical evidence is still unavailable Further, as pointed out above, one must consider the greater risk of failure and the excessive time and effort cost involved in premature instances of intuitive learning, and hence the greater feasibility of postponing entirely the introduction of certain subject matter fields until children are cognitively more mature (adequately ready for them) In general, therefore, it is preferable to restrict the intuitively-oriented content of the elementary school curriculum to materials for which the child exhibits adequate developmental readiness—even if he *can* intuitively learn more difficult, ingeniously presented material beyond his intrinsic level of readiness

In addition, it undoubtedly overstates the case to claim that *any* subject can be taught to children in the pre-operational stage, or in the stage of concrete logical operations, provided that the material is presented in an informal, intuitive fashion with the aid of overt manipulation or concrete empirical props It is readily conceivable that some topics, such as 'set theory, algebra, and quadratic equations in mathematics, can be successfully learned by fourth grade pupils when recast in accordance with their characteristic ways of thinking and conceptualizing experiences (Dienes 1959, 1964) Through such kinds of teaching many more abstract and 'difficult' concepts can undoubtedly be made intuitively comprehensible to elementary school children than was believed possible in the past, and even brought within the category of learnings for which they *are* adequately ready This hardly rules out the possibility, however, that (a) The comprehension of many *other* ideas presupposes certain specific antecedent learnings in a given subject matter area or a certain minimal level of general subject matter sophistication, (b) Some abstractions are so inherently difficult or complex that they cannot be made intuitively understandable to children below a certain level of cognitive maturity—even with the aid of suitable concrete-empirical props, (c) Certain abstractions become relatively useless when restructured on an intuitive basis, and (d) It is virtually impossible in the case of certain highly abstract concepts to find particular exemplars that are meaningful to cognitively immature children These latter kinds of ideas would be *intrinsically* too difficult for preschool or elementary school children irrespective of the method of presentation

Thus, even assuming that all abstract concepts could be restructured on an intuitive basis it would still be unreasonable to expect that they could *all* be made comprehensible to children at *any* grade level Although the intuitive comprehensibility of any given intuitively restructured idea is best determined empirically it would surely be plausible deductively to expect that a certain proportion of these ideas could not be rendered comprehensible to typical pupils in some of the preschool and elementary grades

As F T Tyler points out

> It is difficult to understand how [Bruner] can maintain "that any subject can be taught effectively in some intellectually honest form to any child at any stage of development," and at the same time say first that the "pre-operational child cannot grasp the idea of reversibility and second, because of this fundamental lack the child cannot understand certain fundamental ideas that lie at the basis of mathematics and physics It goes without saying that teachers are severely limited in transmitting concepts to a child at this age even in a highly intuitive manner Grasping the idea of invariance is beset with difficulties for the child often unsuspected by teachers Do common experience and observation not convince us of the impossibility of teaching such a class of responses as solving linear equations to a neonate (Tyler 1964 pp 220 223)

### *Accelerating Stages of Intellectual Development*

Is it possible to accelerate children s progress through the pre-operational stage or the stage of concrete logical operations by taking account of their characteristic cognitive limitations and by providing suitably contrived experience geared to their cognitive capacity and mode of functioning Can we for example train them as Inhelder (Bruner 1960 pp 43-45) suggests to focus on more than one aspect of a problem at a time or to acquire genuine appreciation of the concept of conservation of mass If stages of development have any true meaning the answer to this question can only be that although some acceleration is certainly possible it is necessarily limited in extent.

Developmental considerations inevitably impose a limit on the extent of acceleration that is possible inasmuch as transition to the next higher stage is invariably an organic outgrowth of and hence presupposes, the attainment of a certain level of consolidation or proficiency at the preceding stage Such consolidation in turn implies gradual and cumulative change over an extended period of time In accounting for the transition from the pre-operational stage to the stage of concrete logical operations Piaget (1957b) for example emphasizes such mechanisms as successive and contrasting decentration" (less exclusive preoccupation with a particular aspect of a phenomenon) and gradual appreciation of the theory of probability

In our opinion however Piaget unwarrantedly excludes the role of training and education, particularly the role of verbal instruction, in bringing about transition from one stage of intellectual development to another As L S Vygotsky (1962) points out, the relationship between intellectual development and education is reciprocal On theoretical grounds there is no reason why *only* incidental (spontaneous, undirected, unexplained) experience must effect the gradual, cumulative change in intellectual capacity that makes transition to a higher stage possible, and since guided practice is demonstrably more efficient than incidental learning, it should be quite possible for suitable training to accelerate the rate at which the various stages of intellectual development succeed each other In fact, evidence was presented earlier which indicates that schooling and urban living accelerate the acquisition of conservation and of combinatorial reasoning But it was also pointed out above that the mere fact that a given type of learning task *can* be mastered before the age of readiness or that the age of readiness itself *can* be accelerated does not necessarily mean that stages of development *should* be accelerated or that maximum acceleration is desirable

Generally speaking, simple drill or training, in which the pre-operational child is exposed to contrived conservation experience and given reinforcement for correct responses, does not suffice to bring about stable acquisition of conservation concepts Such training merely leads to the acquisition of an 'empirical rule, which, unlike the stable and organized concept in the 'natural conserver,' cannot withstand (is easily extinguished by) the influence of such spurious disconfirmation experience as counter suggestion and perceptually deceptive appearances (Smedslund, 1961) Similarly, in another area of intellectual functioning, kindergarten children who receive laboratory training in learning the principle of a teeter totter (that the longer side of the fulcrum falls when both sides are equally weighted), fail to exhibit resistance to the later learning of a spurious causal relationship about the operation of a teeter totter (that the color of the blocks placed at either end of the teeter totter is the determining factor) (Ausubel and Schiff, 1954) H Beilin and I Franklin (1962) also report that no first grader achieves operational area measurement even with training , and J F Wohlwill and R C Lowe (1962) found improvement in conservation behavior on a nonverbal post test after three kinds of training, but no transfer of this conservation learning to a verbal post test

Considerable evidence, however, indicates that the use of various verbal *didactic* procedures (prior verbalization of principles, the use of verbal rules, filmed verbal explanations, confronting the child verbally with his own contradictions) in conjunction with concrete empirical props *can* accelerate the acquisition of conservation and probability theory (Frank, in Bruner, 1964, Kohnstamm, 1966, Ojemann and Pritchett, 1963, Ojemann, Maxey, and Snider, 1966, Sullivan, 1966) Such didactic teaching combined with the use of concrete empirical props, also induces generalization of conserva on an intuitive basis it would still be unreasonable to expect that they could *all* be made comprehensible to children at *any* grade level Although the intuitive comprehensibility of any given intuitively restructured idea is best determined empirically it would surely be plausible deductively to expect that a certain proportion of these ideas could not be rendered com prehensible to typical pupils in some of the preschool and elementary grades

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Thus it appears that after a certain degree of consolidation of the pre operational stage occurs, one can anticipate, and thereby accelerate, the attainment of the next higher (concrete operational) stage by training the child under the learning conditions that apply to the latter stage by requiring him to relate secondary abstractions and abstract verbal propositions to cognitive structure with the aid of concrete-empirical props In a similar way, the transition from concrete to abstract logical operations can be facilitated by gradually withdrawing concrete-empirical props as the prior stage becomes consolidated, that is by withdrawing the props well in advance of the actual attainment of abstract cognitive functioning [12] Thus in L S Vygotsky s (1962) terms didactic instruction can and *normally* does play a role in facilitating (accelerating) transition from one stage of cognitive development to another—both by providing suitably contrived directed, and explained learning experience, and by making intellectual demands on pupils that go beyond their *current capabilities, that is that anticipate* or are pointed toward the conditions of cognitive functioning at the next higher stage

### *Can Children Learn Anything More Efficiently than Adults?*

Related to the proposition that children can learn anything that adults can—provided that it is suitably presented—is the contention that they can also do so more efficiently David Page for example, makes the following assertion

> In teaching from kindergarten to graduate school I have been amazed at the intellectual similarity of human beings at all ages although children are perhaps more spontaneous creative and energetic than adults As far as I am concerned young children can learn almost anything *faster* than adults do if it can be given to *them in terms they understand* (Bruner 1960 pp 39-40)

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[12] P Ya Galperin (1957) describes a method of teaching arithmetic to slow learning pupils in which concrete-empirical props are eliminated very gradually and are replaced by abstract verbal representations

In our opinion although this proposition is generally untrue and unsupportable it is nevertheless valid in a very limited sense of the term Even more important however it is in many instances partially true for reasons that are very different from those offered by its advocates

Many reasons exist for believing that under *certain* conditions young children *can* learn more efficiently than older and intellectually more mature persons In the first place older individuals particularly if miseducated must often unlearn what they have previously been taught before they are ready for new learning This is frequently the case when a student s knowledge is unclear unstable or disorganized because of a prior history of rote or nonmeaningful learning Second older individuals are more likely to have emotional blocks with respect to particular subject matter areas Third their intellectual abilities tend to be more highly differentiated Finally there is a marked falling off of intellectual enthusiasm venturesomeness and flexibility as children move up the academic ladder

Generally speaking however adolescents and adults have a tremendous advantage in learning any new subject matter—even if they are just as unsophisticated as young children in that particular discipline This advantage inheres in the fact that they are able to draw on various transferable elements of their *overall* ability to function at the abstract level of logical operations Hence in their initial contact with a new discipline they are able to move through the concrete intuitive phase of intellectual functioning very rapidly and unlike the comparably unsophisticated child who functions *generally* at the level of concrete logical operations they are soon able to dispense entirely with concrete-empirical props and with intuitive understandings These facilitating transferable elements as indicated above include the possession of transactional terms and higher-order concepts as well as successful past experience in *directly* manipulating relationships between abstractions (without the benefit of concrete-empirical props)

The advocates of the child superiority proposition maintain however that this rapid shift on the part of older learners from a concrete intuitive to truly abstract and verbal level of intellectual functioning in the unfamiliar new subject matter area results in *less* efficient learning processes and outcomes Research findings nevertheless suggest precisely the opposite conclusion namely that genuinely abstract and verbal learning is both more efficient and yields a more precise general and transferable form of knowledge than its concrete intuitive and verbal counterparts To argue that a more primitive type of learning is more natural because it occurs before a more advanced type of learning and that it is also more efficient because it is more natural is a circular type of reasoning that overlooks the obvious facts that (a) The earlier learning process is used first not because it is more efficient but because it is the *only* mode of learning possible at the lower level of development and hence is more natural only for this reason and (b) When a more advanced learning process is available at a later stage of development it is both less natural and less efficient to use its more primitive precursor

A final argument sometimes advanced for the child superiority proposition is that since there are allegedly optimal ( critical ) periods of readiness for all kinds of developmental acquisitions many intellectual skills can be acquired more easily by younger than by older pupils But although this argument is supported by some aspects of motor physical and perceptual development it has still to be validated in the field of intellectual development

RELATIVE LANGUAGE LEARNING ABILITY OF CHILDREN AND ADULTS To begin with we must appreciate the fact that the child does *not* learn his native language with phenomenal ease and rapidity Quite the contrary! His acquisition of his mother tongue is a long slow and arduous process—despite prolonged and continuous exposure, and despite exceedingly strong motivation to learn so that he can communicate with adults and peers Typically he is 4 years old before his use of syntax even begins to approximate the conventional standards of his language (Ervin and Miller 1963)

In natural settings (home neighborhood school) where children are completely or partially immersed in a second language environment it is true that they *appear* to learn the language more readily than adults do under similar circumstances Actually however the two situations are hardly comparable Children receive much more practice in the new language since they are less able to maintain contact with spoken and written sources of their native language Their motivation is also usually higher because mastery of the second language is more essential for communication peer relationships and school progress Furthermore they are typically less self conscious than adults in attempting to speak the new language

Objective research evidence regarding the relative learning ability of children and adults is sparse but offers little comfort to those who maintain the child superiority thesis Although children are probably superior to adults in acquiring an acceptable accent in a new language E L Thorndike and others (1925) found many years ago that they make less rapid progress than adults do in other aspects of foreign language learning when learning time is held constant for the two age groups [13]

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[13] Elementary school children on the average learn less French in three years than do college freshmen in a single semester (Dunkel and Pillet 1957) However there is a low but consistent negative relationship between chronological age and the Spanish achievement test scores of elementary school pupils (Johnson Ellison and Flores 1960) Johnson in a personal communication attributes this relationship to the younger learner s greater facility in pronunciation listening comprehension and rote linguistic expression despite less mastery of the grammatical structure of the language

In addition to the pronunciation or mimicry factor, children probably have some other intrinsic advantages over adults in foreign language learning. Their intellectual capacities are less differentiated along particular lines, and they are more venturesome and less rigid in undertaking new learning tasks. As a result of fewer past frustrating experiences in academic work, they are also less likely to manifest strong emotional blocks in particular subject matter areas.

The disadvantages of adults in these latter respects, however, are more than counterbalanced by three overwhelming advantages which they enjoy. First, they have a much larger native language vocabulary than children do, particularly with regard to abstract concepts. Hence, in learning a foreign language, unlike children, they need not acquire thousands of new concepts but merely the new verbal symbols representing these concepts. Second, in learning the structure of a new language—both in comprehending oral and written materials and in speaking—they can make conscious and deliberate use of grammatical generalizations and can explicitly apply them to suitable exemplars. Young children, on the other hand, are limited to the much less efficient approach of discovering syntactical rules through repetitious exposure to models and corrective feedback. Largely because of these two factors, certain characteristic features of the audiolingual method are pedagogically inappropriate for adults. Finally, adolescents and adults possess a larger store of propositions in cognitive structure under which new phrases and sentences can be subsumed. This enhances the comprehension of foreign language material.

## Educational Implications of the Transition from Concrete to Abstract Cognitive Functioning

From the standpoint of the secondary school teacher, the most significant development in cognitive functioning that occurs during the preadolescent and early adolescent years is the gradual transition from a predominantly concrete to a predominantly abstract mode of understanding and manipulating complex abstract propositions. This developmental shift has far reaching implications for teaching methods and curricular practices in the secondary school.

Once the developing individual reaches the abstract stage of cognitive functioning he becomes in large measure an abstract verbal learner. He now acquires most new concepts and learns most new propositions by *directly* (without the mediating and constraining influence of concrete-empirical props) apprehending verbally or symbolically stated relationship between previously learned abstractions. To do so meaningfully, he need no longer refer to first hand, concrete, or nonrepresentational experience, nor actually perform any of the abstracting or generalizing operations on the underlying empirical data. With his developmental dependence on concrete empirical props removed, the only condition necessary for the understanding and meaningful manipulation of higher-order concepts and abstract propositions is that their substantive import be nonarbitrarily relatable to his particular cognitive structure, and that he adopt a set to learn them in this fashion. Hence, on developmental grounds, he is ready at the secondary school level for a new type of verbal expository teaching that uses particular examples primarily for *illustrative* purposes, that is, to *clarify or dramatize truly abstract meanings rather than to make possible the emergence of intuitive meanings*.

It would be very misleading, however, to assert that secondary school and even older students can *never* profit either from the use of concrete empirical props to generate intuitive meanings or from the use of inductive discovery and deductive problem solving techniques to enhance such meanings. As previously suggested, generally mature students tend to function at a relatively concrete or intuitive level when confronted with a particularly *new* subject matter area in which they are as yet totally unsophisticated. But since abstract cognitive functioning in this new area is rapidly achieved with the attainment of a minimal degree of subject matter sophistication, concrete empirical props and discovery methods should be employed to generate and enhance intuitive learnings only during the *early* stages of instruction. Continued use of discovery techniques for other purposes, however (to improve problem solving skills, to foster appreciation of scientific method, or to test verbal understanding), is thoroughly defensible. And once students function abstractly in a given discipline, it is one thing for teachers to use examples and analogies *occasionally* to clarify the *abstract* meanings of particularly difficult or unfamiliar new concepts or principles, but it is quite another for teachers to use them *routinely* either as invariably necessary props for transmitting *all* abstract meanings or in the mistaken belief that students are *still* functioning or would be *better off* still functioning on an intuitive level.

Since a largely abstract and verbal type of expository teaching is both more economical in terms of time cost and also leads to abstract verbal understandings that are qualitatively superior to and more transferable than intuitive understandings, one might reasonably ask why the secondary school has not placed greater emphasis on more abstract and verbal techniques of effecting meaningful verbal learning. In the first place, by unwarrantedly extrapolating childhood learning conditions to adolescence and adult life, the progressive education movement fostered widespread acceptance of the proposition that all verbal concepts and generalizations are *necessarily* nothing more than rotely memorized glib verbalisms unless they both reflect current or recent concrete experience and are products of independent problem solving or discovery. This belief led, in turn, to the summary re jection of verbal exposition and to the paradoxical acceptance of such inherently rote problem solving and discovery practices as the teaching of type problems the wholly mechanical manipulation of mathematical symbols and the performance of cookbook laboratory experiments

Second the tendency among educational psychologists uncritically to extrapolate findings from laboratory studies of nonverbal or rote verbal learnings to meaningful verbal learning in the classroom reinforced the educator s perception of verbal learning as necessarily rote in character and further encouraged him to repudiate expository verbal teaching Lastly the failure of educational psychologists to investigate the nature and conditions of meaningful verbal learning and retention delayed the discovery of more effective techniques of verbal exposition as well as helped perpetuate the use of traditional rote techniques Only within the last few years have curriculum specialists and educational psychologists concerned themselves with substantive and programmatic aspects of the problem of facilitating the meaningful acquisition and retention of viable bodies of knowledge

The fact that children become less empirical and more hypothetical in their approach to scientific problems with increasing age does not necessarily mean that they accordingly rely more blindly on authority and show less appreciation of scientific method J Piaget (1928 1932) has shown that quite the opposite holds true The decreased emphasis on an empirical approach with increasing age is simply a function of cognitive maturation that is of greater ability to grasp concepts and generalizations on a purely abstract basis without prior need for experience with multiple particular instances of a concrete nature

## Developmental Considerations Regarding Breadth of Curriculum

One of the chief complaints of the critics of public education in the United States is that contemporary children fail to learn the fundamentals because of the broadening of the elementary school curriculum to include such subjects as social studies art science music and manual arts in addition to the traditional three R s This of course would be a very serious charge if it were true because the wisdom of expanding a child s intellectual horizons at the expense of making him a cripple in the basic intellectual skills is highly questionable to say the least Fortunately however the benefits of an expanded curriculum have thus far not been accompanied by a corresponding deterioration in the standard of the three R s Evidently the decreased amount of time spent on the latter subjects has been more than compensated for both by the development of more efficient methods of teaching and by the incidental learning of "fundamentals" in the course of studying these other subjects. Nevertheless, the issue of breadth versus depth still remains because there *is* obviously a point beyond which increased breadth could be attained only by sacrificing mastery of the fundamental skills, and even if we agreed to maintain or improve the present standard of the three R's, we would still have to choose between breadth and depth in relation to other components of the curriculum, particularly at the junior and senior high school levels. It is at these points of choice that developmental criteria can be profitably applied.

### *Concrete-Intuitive Stage*

Generally speaking, maximal breadth of the curriculum, consistent with adequate mastery of its constituent parts, is developmentally desirable at all ages because of the tremendously wide scope of human abilities. The wider the range of intellectual stimulation to which pupils are exposed, the greater are the chances that all of the diverse potentialities both within a group of children and within a single child will be brought to fruition. By the same token, a broad curriculum makes it possible for more pupils to experience success in the performance of school activities, and thus to develop the necessary self-confidence and motivation for continued academic striving and achievement.

The very fact that elementary school children are able to make significant progress in science and social studies also indicates that myopic concentration on the three R's would waste much available readiness for these other types of learnings and thus compel junior and senior high schools to devote much of their instructional time to materials that are easily learnable in the lower grades. In fact, one of the major failings of the secondary school curriculum today is that because it still has not adequately adjusted to the expansion of the elementary school syllabus, entering pupils are not only subjected to much stultifying repetition but also fail to break the new ground for which they are obviously ready.

Other factors similarly counsel a choice of breadth over depth in the content of the primary school curriculum. First, from a logistical standpoint, the young child is not prepared for depth of subject matter coverage. His limited attention span and his dependence on concrete empirical props greatly limit the rate at which he can learn new material, thereby making it difficult for him to assimilate a wide array of information about a given topic, and the limited number of abstractions in his cognitive structure, as well as the particularized, semiabstract, and relatively unprecise nature of his concepts and principles likewise detract from his ability to assimilate and integrate large quantities of subject matter knowledge.

Second, the relationship between breadth and depth must also take into account the progressive differentiation of intelligence interests and personality structure with increasing age The elementary school child is a generalist because both his intellect and personality are still relatively unstable and uncrystallized and lack impressive internal consistency Thus many different varieties of subject matter are equally compatible with his interest and ability patterns Furthermore unless he has experience with many different fields of knowledge and gives each a provisional try he is in no position to judge which kinds of intellectual pursuits are most congruent with his major ability and value systems Hence quite apart from the future life adjustment values of a broad educational background it is appropriate on developmental grounds for elementary and early high school curricula to stress breadth rather than depth

Breadth of course inevitably implies a certain amount of superficiality This superficiality however is not necessarily opprobrious Whether it is desirable or undesirable cannot be judged in absolute terms but only in relation to the student s intellectual readiness for depth It should also be pointed out in this connection that superficiality itself is always a relative state of affairs the graduate school curriculum is just as superficial to the post doctoral scholar as the elementary school curriculum is to the college undergraduate The spiral curriculum—the reintroduction of the same topics in progressively greater depth as intellectual readiness and maturity increase—is predicated on this assumption

Superficiality is also not synonymous with triviality or with slipshod unsystematic or outdated teaching Good teaching implies precise presenta tion of significant organized lucid and valid content at any level of breadth and even at the elementary school level it allows for the occasional introduction of atypical depth both substantively and methodologically to give the student a taste of scholarship and of research inquiry But as will be pointed out later the probing in depth of isolated areas apart from the systematic presentation of subject matter—merely as a means of en hancing inquiry skills or methodological sophistication—is indefensible at any age level and particularly in the elementary school It is a type of activity suitable for the scholar and research scientist—*after* he has acquired substantive and methodological sophistication in his field

### *Abstract Verbal Stage*

Toward the latter portion of the junior high school period however precisely the opposite kind of developmental situation begins to emerge Interests have crystallized and abilities have undergone differentiation to the point where greater depth and specialization are possible and desirable Many students at this stage of intellectual development are ready to sink their teeth into more serious and solid academic fare but unfortunately suitable instructional programs geared at an intermediate level of systematic presentation of the fundamental principles of a discipline are all too rarely available The changes that have taken place in secondary school curricula since the academy days have been primarily characterized by the belated and half hearted addition of more up-to-date and topical information Very little has been done in the way of providing the student with a meaningful, integrated, and systematic view of the major ideas in a given field of knowl edge

The transition from concrete to abstract cognitive functioning enables the secondary school student to master a much greater volume of subject matter knowledge To begin with, the logistics of the learning situation become more favorable His ability to understand abstract propositions *directly* (to dispense with the time consuming operations of using both concrete-empirical props and discovery and problem solving experience to generate and enhance intuitive insights) permits the teacher to present much more subject matter in the same period of time In addition, both the much larger body of abstract concepts and principles in his cognitive structure, and his qualitatively higher level of abstract understanding, make possible a more efficient means of assimilating organizing, and integrating the materials that are presented Because the established higher-order concepts and relational propositions in his cognitive structure are no longer intuitive, but are meaningfully formulated in truly abstract and general terms they are clearer, more stable, and more precise than they were in childhood, and are sufficiently inclusive to subsume a wider array of differentiated facts and subconcepts

In view of these latter developments and of the greater differentiation of his abilities and interests the secondary school student is prepared to cope with greater depth as well as with greater breadth, of subject matter He is ready for more intensive and differentiated coverage of smaller areas of knowledge as opposed to more global and superficial coverage of larger areas Depth in this context however, primarily implies greater substan tive density of knowledge rather than greater degree of autonomy in dis covering the principles and obtaining the information to be learned If the secondary school student is required to discover most principles auton omously, to obtain most subject matter content from primary sources, and to design his own experiments he has time to acquire only methodological sophistication in terms of *substantive* depth, he simply moves from a previ ously superficial coverage of broad areas to a comparably superficial coverage of more circumscribed areas The real aim of secondary school and undergraduate education is not to produce substantively ignorant junior scholars and scientists but to produce students who are knowledgeable both in breadth and depth of subject matter

Chapter 6

# INTELLECTUAL ABILITY

IN THIS CHAPTER we propose to discuss the nature and growth of intelligence considered as a *measurement construct designating general level of cognitive functioning* Developmental changes in the actual psycho logical capacities and processes involved in cognitive functioning, namely, symbolization, language use, concept formation, and problem solving are considered in Chapters 2, 5, 15, and 16 When level of ability in performing these functions is measured by a graded series of tasks and regarded as representative of a *general* capacity for processing information and for utilizing abstract symbols in the solution of abstract problems, the construct designat ing this measured capacity may be referred to as intelligence An intellectual ability, in other words, is really nothing more or less than a *functional* manifestation of a distinct and identifiable cognitive process as expressed in a range of individual performance or capacity differences Since the nature of cognitive processes varies in accordance with stage of development, tests of intellectual ability should take account of and try to reflect stage-related, qualitative changes in cognitive functioning (Flavell, 1963, Lauren deau and Pinard, 1962, Smedslund, 1964)

## The Nature of Intelligence

In the sense that the construct of intelligence is derived from a particu lar set of measurement operations, it is obviously an abstraction that has no real existence apart from these constituent operations It is also an abstraction in the sense that a *general* level of cognitive functioning has no actual reality apart from the *particular* kinds of cognitive functioning represented in an intelligence test Nevertheless, insofar as the construct is logically tenable, related to naturalistic data, and derived from relevant and technically appropriate operations it is by no means merely an arbitrary and fictitious invention of psychologists It is definitely related to an existing state of affairs in the real world (cognitive capacity) and has much theoretical and practical value both in explaining cognitive and other aspects of behavioral development and in predicting the cognitive level at which individuals function

The concept of intelligence by definition clearly excludes level of functioning in all *noncognitive* areas of behavior This definition renders largely irrelevant the commonly voiced criticism that the IQ is misleading because it does not indicate an individual s capacity for coping with non representational concrete mechanical or interpersonal problems The IQ is not intended to represent these latter capacities and no claim is made that it does In fact if the intelligence test were modified so that it *could* perform these functions it would automatically lose whatever effectiveness it possesses as a measure of cognitive ability The argument here is not that indices of maturity level in other noncognitive areas are theoretically or practically unimportant but rather that it is utterly naive to expect a single instrument adequately to measure several largely unrelated kinds of abilities

Also irrelevant in much the same sense is the criticism that the IQ does not indicate *particular* cognitive strengths and failings or *typical* ways of attacking problems No single *summary* score could possibly do so If such information is desired it is available in the detailed test protocol from which the IQ is derived and in the qualitative observations of the examiner Quite beside the point also is the frequently voiced complaint that the intelligence test fails to identify *creativity* As will be pointed out in Chapter 16 creativity refers to a unique degree of originality in some *substantive* area of human endeavor and not to the possession of a high degree either of general intelligence or of one of its component abilities

Much futile controversy rages over the issue of whether or not the intelligence test measures *native* (genically determined) *cognitive endowment* Although an effort is made to maximize the influence of *genic* factors by using test items that presuppose only very *generally available* kinds of experience it is obviously impossible to rule out the differential effects of exposure to different types of cognitive experience to different levels of cognitive stimulation and to different personality and motivational variables Hence intelligence can be regarded only as a *multiply determined functional capacity* the level of which in a given individual reflects the relative potency of these various factors as they exist and interact in his particular case Most general intelligence tests for instance the Binet type explicitly attempt to avoid the impact of *particular* kinds of past experience by presenting the subject with relatively *novel* tasks Even so however many of the component sub-tests such as vocabulary obviously reflect the influence of environmental factors for example of social class membership and cultural deprivation Special aptitude tests such as language usage are even more dependent on the nature of prior experience and social class background

Another equally pointless controversy is the argument over whether the intelligence test score is a measure of performance or capacity Obviously capacity cannot be measured directly and must therefore be *inferred* from performance but if the IQ were only an index of how adequately an individual utilizes his cognitive capacity (performs) rather than an index of existing capacity *itself* its theoretical and practical usefulness would be seriously limited Hence the more meaningful and relevant question here is whether capacity can be validly *inferred* from performance or whether test performance provides a *fair* sample of capacity An affirmative answer to this question is indicated if (a) the test includes a representative sample of cognitive functions (b) the specific items on the test are related to equally available experience and (c) the individual is motivated to perform as well as he can If the latter two conditions are not met performance is an underestimate of capacity and subsequent improvement in score that is attributable to correction of test disadvantage or inadequate test motivation reflects a gain in performance rather than a gain in capacity All increments in IQ however do not necessarily fall in this category of more efficient utilization or fairer opportunity of displaying unchanged capacity If the change is brought about through significant alterations in level of cognitive stimulation or in personality structure it is reflective of a *genuine* change in capacity since cognitive capacity (according to the definition of intelligence adopted above) refers to a multiply determined phenotype (actualized genic endowment) rather than to genic potentiality

If we are primarily interested in using IQ scores as predictors of an individual s actual academic achievement we would perhaps be better advised to obtain them under *typical* motivational conditions In this case they would be more reflective of performance than of capacity

In this chapter we shall be concerned with such *general* issues as the nature of intelligence what IQ tests purport to measure the organization of intelligence in terms of its component abilities and the distribution of IQ scores We shall also discuss various *developmental* issues bearing on intelligence when intelligence is considered either in absolute terms (as a developmental or mental age) or relative to group norms (as a developmental quotient—IQ or brightness level) These issues include (a) quantitative and qualitative changes in intelligence with increasing age (b) the constancy of individual rates of growth and (c) the nature nurture problem —the relative contributions of heredity and environment to the development of intelligence and the extent to which intelligence is modifiable

## *Are Intelligence Tests Unfair to Culturally Deprived Children?*

'Liberal' educators often unwarrantedly castigate the intelligence test as being unfair to the culturally deprived child, both because it emphasizes verbal ability, rather than the mechanical and social kinds of abilities in which lower class children excel, and because the middle-class environment is more propitious than the lower class environment for the development of verbal intelligence Reasoning such as this, for example, led to the recent (1964) decision to ban group intelligence tests from the New York City Public Schools Actually, however, the intelligence test is not *really* unfair to the culturally deprived child on either count In the first place, it purports only to measure verbal ability and to predict school performance—not ability or performance in the mechanical and social areas Second, any intelligence test can hope only to measure *functional* or operating capacity at a given point of development (degree of actualized genic potentiality) rather than innate potentiality *itself* Adequacy of environmental stimulation is always a significant determinant of functional capacity and hence affects performance on an intelligence test If the environment is inadequately stimulating then functional capacity is naturally impaired But this does not mean that our measuring instrument, the intelligence test, is unfair, since its function is merely to identify and measure impaired operating capacity *irrespective* of the *origin of the impairment* The intelligence test, in other words purports to *measure* functional capacity rather than to *account* for it If the culturally deprived child scores low on an intelligence test because of the inadequacy of his environment, it is not the test which is unfair but the social order which permits him to develop under such conditions

By the same token, we would not say that the tuberculin test is unfair or invalid because (a) the lower-class child really does not have any greater genic susceptibility to tuberculosis but happens to live in an environment that predisposes him to this disease, or (b) it measures exposure to a particular disease which happens to be related to lower social-class status rather than to one which is not so related In terms of operating functional capacity, an intelligence test is no less fair or valid because a low score is reflective of culture deprivation than because it is reflective of low genic endowment Furthermore to argue that intelligence test scores are valid is not to claim that they are necessarily immutable irrespective of future environmental conditions or to defend those aspects of the social system that give rise to the culturally deprived environment

Traditional verbal intelligence tests *are* unfair to culturally deprived children in the sense that such children, in comparison with their middle class agemates have fewer test taking skills are less responsive to speed pressure are less highly motivated in taking tests have less rapport with the examiner and are less familiar with the specific vocabulary and tasks that make up the content of the test (Haggard 1954 Riessman 1962) The tests are therefore unfair in that they do not give the lower class child a fair opportunity to demonstrate his true attained level of cognitive capac ity When these errors of measurement are eliminated however substantial social class differences in IQ still remain (Coleman and Ward 1955 Haggard 1954) These may reflect both hereditary and environmental influences R B Cattell (1963) postulates that culture free tests emphasizing crys tallized as opposed to fluid abilities are fairer to culturally deprived children

Even if culture free tests are devised which minimize the effects of cultural deprivation and give a theoretically truer picture both of the cul turally deprived child s genic endowment and of his attained level of cognitive capacity it is likely

> that these tests in comparison with tests reflecting experiences within the cul ture will predict less well those behaviors dependent upon cultural differences Furthermore one can argue that since the growth of intelligence does not occur in a vacuum but is nourished by the cultural milieu the impact of the culture on tests should not be ignored (Millman and Glock 1965 p 21)

### *The Organization of Intelligence*

How are intellectual abilities and scholastic aptitudes organized? The answer to this question is both complex and technical and goes far beyond the legitimate scope of any textbook in educational psychology Suffice it to say that the organization of intelligence depends in large measure on the age of the pupil in question

The weight of the evidence indicates that intelligence consists both of a *general* or unitary ability as well as of a constellation of discrete and separately measurable abilities or aptitudes The relative importance of these two characteristics varies as a function of age Typically the various sub abilities measured by an *IQ test* intercorrelate about 40 that is show a moderate degree of generality This reflects both the general and special ized nature of the intellectual abilities comprising intelligence or general scholastic aptitude Thus the significance and predictive value of a com posite score on a general intelligence test depend both on the age of the subject and on the purpose for which predictions are made The tendency in recent years at least for older students has been to place greater reliance on the measurement of diverse and relatively separate abilities This ap proach however has undoubtedly been carried to an extreme by factor analysts such as J P Guilford (1959) The latter suggests that there are 120 separately identifiable mental abilities comprising the structure of intellect and that these consist of the various combinations relating to five classes of operations four kinds of content, and six types of product [1] Actually, only about a half-dozen factors such as vocabulary, spatial relations, number ability, numerical reasoning and language usage, have been well established and shown to have predictive value for related aspects of academic achievement

## Distribution of IQ Scores

A characteristically wide and continuous range of variability is typical of the distribution of IQ scores This distribution is consistent with the interpretation that intelligence (like most human traits) is *polygenically* determined, that is determined in large part (but not exclusively) by the cumulative and additive effects of a large number of genes, each of which exerts a small positive or negative effect on the development of the trait Approximately 64 percent of all IQ scores fall between the range of 85 and 114 (Terman and Merrill 1937) A somewhat smaller range of variability prevails with respect to achievement test scores inasmuch as the uneducable mentally handicapped do not attend school

Intelligence tests continue to yield normal distributions during the course of adolescence (Cornell, 1936, E L Thorndike, and others, 1926) Variability in test scores at any age or grade level is considerable The distribution of mental ability, for example, among 14 year-old students in New York State is represented by a range of mental ages from 10 to 18 with the mode at 14 (Cornell 1936)

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[1] Guilford s factors are derived from a purely hypothetical three dimensional model comparable to the periodic table of chemical elements except for the fact that it is wholly speculative rather than based on a projection from known empirical data Not only has the existence of many of these factors never been empirically demonstrated but also most of the demonstrated factors have not been shown to have any predictive significance for academic achievement vocational accomplishment or anything else The low intercorrelations among Guilford s tests purporting to measure the same factorially pure ability (Guilford 1964) suggest in addition that scores on these tests are reflective of highly specific situation bound abilities rather than of true intellectual sub-abilities that manifest generality of function and hence psychological reality and significance

It should also be pointed out that factor analysis is merely a statistical method of reducing the number of abilities measured by a given test(s) to the smallest number of common denominators capable of accounting for most of the variance in a particular population The number of factors that emerge from a given analysis depends in large measure therefore on the particular tests used at what point the investigator chooses to stop the reduction process and how he chooses to conceptualize interpret and name the least common denominators that emerge

Surprisingly enough, despite the tremendous increase in high school enrollment from 1916 to 1940, with a corresponding elimination of the intellectual selectivity that formerly operated when only one third of the adolescent population attended high school, there has been no drop in the mean IQ of the high school population (Finch, 1946) This phenomenon may perhaps be accounted for by the greater experience that present day students have with tests, and by the closer correspondence between currently stressed learning outcomes of school instruction and the types of capacities measured by intelligence tests

## Developmental Changes in Intelligence

In addition to such *quantitative* developmental considerations as the growth curve of intelligence and the constancy of individual rates of growth, we must consider such *qualitative* developmental changes as age level changes in ability to process large bodies of organized and potentially meaningful bodies of information, in the organization of intellectual abilities, and in the breadth and depth of subject matter knowledge ("horizontal growth")

### *Growth Curve of Intelligence*

Most investigators agree that the growth of intelligence is most rapid in infancy and early childhood and tends to increase thereafter at a progressively decreasing rate This conclusion is in accord with everday experience and with the fact that overlapping between score distributions of adjacent age groups increases with advancing age (Bayley, 1933b) A linear growth curve of intelligence is simply an artifactual outcome of plotting mental age in terms of units that are deliberately calibrated so that one year of intellectual growth is, on the average, achieved during the course of a calendar year In general, the growth curve of general intelligence is negatively accelerated (shows a progressively decreasing rate of growth) when based either on raw scores (Terman and Merrill, 1937), on absolutely scaled[2] scores, or on scaled scores transformed into percentages of adult attainment Some investigators report a slight reversal in the rate of negative acceleration during the preadolescent period (Freeman and Flory, 1937, Terman and Merrill, 1937, Wechsler, 1950) On the basis of scaled

[2] The purpose of scaling is to make raw scores from different tests and from different age groups comparable by expressing them in such a way that at any point of the scale the distances between units of measurement are equal in difficulty value

intelligence test scores, E L. Thorndike, and others (1926) postulated a parabolic growth curve according to which about half of mature intellectual status is attained by the age of 3 More recently, B S Bloom (1964a) reached a very similar conclusion, placing the midpoint of attainment of adult intelligence at age 4 Growth begins to taper off in middle adolescence and continues very slowly thereafter until ultimate capacity is achieved (Bayley, 1949, Freeman and Flory, 1937, Garrett, Bryan and Perl, 1935)

Since the tapering-off process is so gradual it is difficult to tell when growth actually ceases The widely accepted finding of L. M Terman and M A Merrill (1937) that mental age does not increase after the age of 15 is now attributed to the limited ceiling of the 1937 revision of the Stanford Binet test The best estimates, based on testing a wide age sample of a relatively homogeneous population (Jones and Conrad, 1944, Wechsler, 1944), or on retesting the same population at suitable intervals (Bayley, 1955, Freeman and Flory 1937, Jones and Conrad, 1944, E L. Thorndike, 1926, 1928), place the age of terminal growth at 18 to 20 and even beyond Gains in intelligence test scores have been reported at age 25 on the Wechsler Bellevue test (Bayley, 1955) and at age 50 on the Army Alpha (Owens 1953) and Concept Maturity tests (Bayley and Oden, 1955) The age of terminal growth obviously varies for different individuals and for different kinds of cognitive processes (Jones and Conrad 1944)

The growth of intelligence—considered as a measurement construct—is the least typical aspect of adolescent development In all other components of growth—hormonal skeletal, motor, personality, moral and social—there is an accelerated period of transitional development or a growth spurt[3] Intellectual growth on the other hand follows a pattern very similar to the development of fine mechanical abilities Of all the major tissues of the body and segments of personality it seems that only the small muscles and intelligence remain unaffected by the catalytic impetus to growth supplied by pubescence Their development continues to respond to the hereditary and environmental influences impinging upon them, just as if pubescence were not taking place, and their growth curves proceed smoothly unmarked by any discontinuity to assume the adolescent form that could be projected for them from developmental data of earlier years

Growth of this kind is not unimportant In such growth, new capacities

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[3] B O Ljung (1965) has recently described an adolescent growth spurt in mental development that is more marked in girls than in boys. But the tests he used were more comparable to academic achievement tests than to conventional intelligence tests and as we know from our description of cognitive development there is a definite spurt at adolescence in ability to master academic subject matter This ability however is hardly synonymous with the construct of intelligence as defined above

are attained by the gradual accumulation of small increments of progress rather than by abrupt and discontinuous spurts of development In terms of *degree of cognitive ability* the adolsecent is a different and more mature person than the preadolescent but not discontinuously so[4] And the acquisition of these increased cognitive abilities plays an important role in personality moral and religious development

The termination of growth in vertical capacity also does not mean that all intellectual development ceases Although beyond this point the individual may be unable to solve more difficult *novel* problems he continues to grow in a horizontal direction—in the sense of increased information knowledge ability to draw upon past experience increased ability to make decisions to form judgments to exercise common sense and so forth (Jersild and others 1946) Also as pointed out earlier because of the shift from concrete to abstract modes of cognitive functioning the capacity both to learn large bodies of subject matter and to reason in terms of abstract general hypotheses (to use propositional logic) shows a discontinuous rate of increase And since the majority of problems an individual encounters can hardly be classified as novel the continuing horizontal growth may be of much greater practical significance than the level of vertical growth already attained

GROWTH CURVE OF SEPARATE INTELLECTUAL ABILITIES Sub test analysis of various tests of intellectual ability shows that several important differences exist in the rate of growth age of terminal growth and rate of decline among the component sub abilities Simple rote memory (memory span) reaches an earlier peak of development than either general intelligence (Conrad Freemen and Jones 1944) vocabulary or arithmetical ability (Garrett Bryan and Perl 1935) but this is not the case with respect to more meaningful and analytical types of memory (Jones and Conrad 1933) During the preadolescent and adolescent periods vocabulary and ability to dissect sentences grow at a more rapid rate than does reasoning ability despite identical rates of growth during early and middle childhood (Conrad Freeman and Jones 1944) Growth of ability terminates earlier on the analogies test than on either the completions or opposites tests On the other hand decline in ability sets in earlier for such functions as analogies and completions than for vocabulary and general information (Jones and Conrad 1933) In conclusion it appears that the more complex intellectual abilities have a more gradual rate of growth reach maturity at a later age (Bradway and Thompson 1962) but show evidence of decline earlier in life

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[4] In terms of *mode* of cognitive functioning however discontinuity in development probably does occur at adolescence

R B Cattell (1963) has isolated fluid and crystallized components of intelligence The crystallized factor consists largely of process functions presumably not much influenced by learning or educational experience and reaches maturity at a relatively early age The fluid factor in contrast consists more of product functions which are appreciably affected by education and experience and therefore reach maturity later in life The so called culturally deprived are naturally much more deficient in the fluid than in the crystallized component of intelligence

*Growth Curves of Bright and Dull Children*

Available evidence indicates that bright dull and average children grow intellectually at different rates and differ with respect to organization and qualitative pattern of cognitive abilities Although the terminal age of intellectual growth is the same for all three groups dull children attain a disproportionately large percentage of their *ultimate* intellectual status during the early years (Bayley 1956) and tend to grow step wise in spurts and pauses (Cornell and Armstrong 1955) Normal children exhibit a more constant rate of growth (Freeman and Flory 1937) whereas bright children show an accelerated rate of growth in later childhood that slows down somewhat in middle and late adolescence (Cornell and Armstrong 1955 Freeman and Flory 1937) The net effect of these differences is that the bright tend to grow away from the dull (Conrad Freeman and Jones 1944 Thurstone and Ackerson 1929) Duller individuals (as might reasonably be anticipated from their greater chronological age) also show greater differentiation of intelligence than do brighter younger children of the same mental age (Thompson and Margaret 1949) Greater differentiation concomitantly makes for decreased plasticity or increased rigidity When chronological age is held constant however differentiation of cognitive traits (Segel 1948) is more marked among bright children (higher mental age *and* higher IQ)

There are also good reasons—from analysis of intelligence test scores alone—for believing that normal (average) cognitive functioning at a given maturity level is *qualitatively* different from the performance of accelerated younger or retarded older individuals of the same mental age First sub scale analysis of the Stanford Binet test shows significant differences between old dull and young bright individuals of comparable mental age in the types of items handled successfully (H E Jones 1931 Laycock and Clark 1942 M A Merrill 1924) Second bright and dull children tend to exhibit more scatter (spread of successes and failures on component sub tests over a wider range of difficulty) on this test than do average children (M A Merrill 1921) Third bright and dull children of equivalent mental age excel in different kinds of cognitive abilities The bright are generally superior in tests demanding comprehension, imagination use of language, reasoning abstraction, and generalization (Aldrich, 1931, K S Cunningham, 1927, Gallagher and Lucito, 1961, Purvis, 1938, Ramaseshan, 1950), the dull are superior in spatial ability (Ramaseshan, 1950), word fluency (Ramaseshan, 1950), and manipulation of concrete materials (Aldrich, 1931) Fourth, normal children do better than mentally retarded children of the same mental age in such school skills as arithmetic reasoning (Dunn, 1954), spelling (Dunn, 1954), reading comprehension (Bliesmer, 1954, Dunn, 1954, M A Merrill, 1924), ability to profit from contextual cues (Dunn, 1954), memory for factual details (Bliesmer, 1954), and understanding of ideational relationships (Bliesmer, 1954) No significant differences were found in the simpler and more mechanical reading skills (Bliesmer, 1954) and in arithmetic fundamentals (Dunn, 1954) Finally, bright and dull children of the same mental age show characteristic differences in approach to problem solving

In view of the fact that they continue to grow in intelligence just as long as their brighter peers, dull students need not drop out of high school at the tenth grade, as they frequently do at present, but could profit from schooling until at least the age of 18 To maximize the benefit that such students can derive from continued instruction, the more difficult subjects could be placed at the end of the high school curriculum, and abstract materials could be concretized and made more meaningful in terms of life situations (Segel, 1948) And in order to recognize their peculiar capacities and help them achieve success rather than failure, the school needs to provide for them a wide variety of learning activities (Segel, 1948)

### *Developmental Changes in Organization*

Since there is much disagreement regarding the way in which intelligence is organized, it is obviously impossible to make any definitive statement about developmental changes in its organization The weight of the evidence, however, points to (a) an initial stage (infancy and the early preschool period) in which the abilities measured by intelligence tests are predominantly perceptual and sensori motor in nature and are largely unrelated both to each other and to later manifestations of abstract intelligence (b) an intermediate stage (from approximately the late preschool period to preadolescence) in which abstract intelligence is highly general in nature, cognitive abilities are highly intercorrelated and (c) a later stage (preadolescence and beyond) marked by increasing differentiation of intellectual abilities

At the age of 5 abstract abilities are much in evidence and are so highly intercorrelated that it is relatively difficult to isolate independent factors In contrast to the eight primary abilities that he was able to identify in a population of adolescents and young adults L. L. Thurstone was able to isolate only five comparable abilities among 5 and 6 year-olds (Thurstone, 1938, Thurstone and Thurstone, 1946) As children grow older, particularly during the preadolescent period and beyond there is evidence from factor analysis[5] of increasing differentiation of intellectual ability (Garrett, 1946 Garrett, Bryan and Perl, 1935, Green and Berkowitz, 1964, Guilford, 1966, Heinonen, 1963, Ljung, 1965, W J Meyer, 1960) *Increased integration* also occurs *within* the various component subabilities (Ljung, 1965)

By the time an individual reaches adolescence, differential factors of interest, relative ability, specialization of training motivation, success and failure experience, and cultural expectation operate selectively to develop certain original abilities and to leave others relatively undeveloped Children with highly differentiated mothers (Dyk and Witkin, 1965) tend to undergo most differentiation Original aptitude and experience seem to reinforce each other in circular fashion since children who are gifted in a particular area benefit differentially from instruction in that area (Lesser, 1962) However, inasmuch as considerable interrelatedness among different cognitive functions still remains (Schulman and Havighurst, 1947) evidence of increasing differentiation at the older age levels does *not* render the concept of general intelligence completely untenable Furthermore, relatively high correlations between intelligence test scores obtained in the primary grades and retest scores obtained during adolescence indicate that there is much overlapping between the factors determining early level of general cognitive ability and later level of differentiated cognitive ability

For practical purposes an intelligence test score has less utility after preadolescence than during the early elementary school years The older child s relative standing in one ability has relatively little predictive value for his relative standing in another ability, and *composite* scores on intelligence tests are not very useful for predicting performance in a *particular* school subject Much more meaningful than a total score is a profile showing the relative standing of an individual on a wide variety of basic intellectual abilities Thurstone s tests of *primary mental abilities, for example* provides such a profile By expressing intelligence in terms of the smallest number of relatively pure and independent factors, it gives a much more definitive, convenient and quantifiable qualitative analysis of cognitive ability than could be obtained from examination of the protocol of the more traditional Binet type scale composed of batteries of heterogeneous sub-tests

In conclusion therefore it can be stated that when differential aptitude batteries purporting to measure only the relatively few and well-established

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[5] Using other kinds of tests P E Vernon (1950) J Cohen (1959) and P E Hagen (1952) failed to obtain consistent evidence of increasing differentiation

primary mental abilities are used, they probably have more predictive value for the *particular* kinds of subject matter achievement for which they are relevant than do composite scores on tests of general intelligence or of general scholastic aptitude However, the latter tests, as Q McNemar (1964) points out, are not completely without psychological significance or predictive value In fact, they are more useful for predicting complex criteria of academic achievement, involving the interaction among several abilities, than are even the well-established differential aptitude batteries, and are incomparably more useful than are differential batteries consisting of unvalidated factors or of factors manifesting little generality of function

The increased differentiation of intellectual ability during adolescence is a *general* phenomenon but also varies in relation to many differential factors D Segel s evidence (1948) shows that differentiation among intellectual traits is greater for bright than for dull adolescents Intellectual abilities are also differentiated along social-class and sex lines and as a result of prolonged or specialized education Especially interesting are data indicating that superiority in a given function reflecting higher *general* ability at a younger age level may undergo reversal during adolescence as a result of differentiation For example girls have higher language *and* arithmetical ability than boys at the beginning of adolescence, but boys eventually surpass them in arithmetical ability before the close of adolescence (Kuhlen, 1952) Children from upper socio-economic groups are superior to lower class children on tests of both verbal *and* mechanical ability at age 10, but at age 16 retain their superiority only on the verbal tests (Havighurst and Janke, 1944 Janke and Havighurst, 1945)

This progressive differentiation of mental ability requires a correspondingly increasing differentiation of curricular offerings As Segel points out, a core curriculum is better suited to the intellectual organization of junior than of senior high school students Another consequence of this increasing differentiation that is apparent from studies of drop-outs from school is

> that between the ages of 10 and 14 maladjustment through lack of general mental ability is an item of importance among the factors causing youth to leave school However between the ages of 15 and 18 such maladjustment does not result in large numbers of youth leaving school (Segel 1948)

### *Constancy of Individual Rates of Growth*

Quite apart from normative fluctuations in the rate of intellectual development it is important to ascertain whether children tend to retain the same *relative* status in their age group as they grow older To the extent that this type of constancy prevails the child s developmental quotient (IQ) will fluctuate little from one age level to another and his score at an earlier stage of development will not only be indicative of his relative status at that age level but will also have predictive value for his relative status at later stages of development The constancy of the IQ may be expressed either in terms of its probable error or in terms of the coefficient of correlation between the intelligence test scores of a group of children that are determined on two separate occasions (the coefficient of stability)

Generally speaking once the IQ approaches stability it tends to remain relatively constant and existing degrees of inconstancy tend to be normally distributed At the age of 9 for example the probable error of an IQ (Terman and Merrill 1937) is about 5 points[6] (varying with brightness level) and the coefficient of stability (with an interval of 3 years between tests) is approximately 85 (Honzik Macfarlane and Allen 1948) The predictive value of the IQ is greatly influenced both by the age of the child at the time of initial testing and by the length of the interval between test and retest The older the child when first tested and the shorter the interval between tests the greater will be the predictive accuracy of the initial test (J E. Anderson 1939 L. D Anderson 1939 Bayley 1940 Bradway and Thompson 1962 Honzik Macfarlane and Allen 1948 W J Meyer 1960) Intelligence test scores gradually become more stable with advancing age and first acquire sufficient stability to be practically useful for predictive purposes when the child reaches school age (Bayley 1949) Stability in *component* mental abilities however is not impressive until the fourth grade and first becomes high enough for boys during the eighth grade to forecast adult aptitudes (Bennett and Doppelt 1951 W J Meyer 1960) Among girls the findings are more equivocal (Meyer and Bendig 1961) In this section we shall consider age level changes in the stability of the IQ as well as various measurement genic and environmental factors that account for both consistency and fluctuations in individual rates of growth

Preschool intelligence tests measure a larger portion of abstract intellectual ability than do infant scales and hence have greater predictive value After the age of 2 scores on preschool tests show a moderate (16 to 66) and progressively increasing correlation with scores determined at the age of 7 (J E Anderson 1939 Honzik Macfarlane and Allen 1948) but it is not until the age of school entrance that scores on intelligence tests are reasonably well correlated with terminal intellectual status (Bayley 1949 Honzik Macfarlane and Allen 1948) If preschool tests are administered accurately and on more than one occasion school age status can be predicted

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[6] This means that one half of the IQ tested persons do not deviate more than 5 points on immediate retesting Over an interval of 6 to 8 years approximately 10 percent of all IQ scores change at least one standard deviation (16 points)

with a degree of error that rarely exceeds one category on a five point scale During the later elementary school years, IQ remains relatively stable, both on a year to year basis and over a period of three or more years (Bayley, 1949, Honzik, Macfarlane, and Allen, 1948) Although some fluctuations in test scores do occur, most children tend to retain the same *relative* position in their age group

When the child is at the age of adolescence, test scores of general intelligence acquire a fair amount of stability The correlation between scores on intelligence tests given at the onset of adolescence with those given at the close of adolescence is in the neighborhood of 80 (J E Anderson, 1940) From year to year this correspondence is even greater (E L Thorndike, 1926) Thus, while some fluctuation in test score occurs in individual growth curves, most individuals tend to retain the same relative position in the group throughout the adolescent period (Freeman and Flory, 1937) In extreme instances, of course, there are large fluctuations in test scores, but these fluctuations tend to be associated with such unusual disorganizing factors in life history as, for example, serious illness (Honzig Macfarlane, and Allen, 1948) rather than with intrinsic irregularity of the growth pattern or unreliability of the measuring instrument For purposes of *individual* guidance, however, a reliability coefficient of 80 is not too reassuring In dealing with a *particular* individual it does not suffice to know that a *majority* of individuals at age 18 will occupy the same relative position in the group with respect to IQ as they did at age 13 There is sufficient variability in individual growth patterns to warrant frequent and periodic testing of intelligence if test scores are to be used at all for guidance purposes

CAUSES OF CONSTANCY AND FLUCTUATION Much of the constancy of the IQ can undoubtedly be attributed to genic factors To the extent that the development of intelligence is determined by polygenic influences, some degree of constancy is inherent in the fact that the genotype of an individual remains invariable throughout his lifetime The environment also accounts for some constancy, since for any particular individual it tends, within limits, to remain relatively stable The relative contributions of heredity and environment to the constancy of the IQ are, of course, proportionate to their relative weights in determining cognitive development A third factor making for constancy is the phenomenon of *developmental irreversibility* or the limiting influence of current developmental status on potentialities for future growth New growth always proceeds from the existing phenotype rather than from potentialities inherent in the genotype If, as a result of a consistently poor environment during the early formative years, existing genic endowment is not actualized the *attained* level of functional capacity (although incommensurate with genic potentiality) significantly limits the extent to which *later* environmental improvement can increase the rate of cognitive growth An individual s prior success in developing his intellectual potentialities in other words tends to keep his future rate of growth relatively constant despite fluctuations in relevant environmental variables Finally constancy is in part a reflection of the overlap that prevails in the intellectual abilities measured by intelligence tests at different age levels (J E Anderson 1939)

Fluctuations in IQ are caused by measurement genic and environmental factors Included under the first heading are (a) errors of measurement inherent in the selection and placement of test items and in the use of items that are not equally representative of generally available experience —thereby leading to variable amounts of test disadvantage at different points in the life cycle and for different groups of children (b) errors of test administration and scoring especially during infancy and early childhood when difficulties of communication are maximal (c) situational variability in such factors affecting test performance as personality of the test administrator rapport (Pasamanick and Knobloch 1955) fatigue physical well being general attitude motivation (Haggard 1954) attention span frustration tolerance self-confidence level of aspiration emotional stability level of anxiety reaction to failure venturesomeness and negativism (Rust 1931) (d) variation in the standardization sample over the age range (e) variation among age groups in test ceiling and in degree of variability of test scores and (f) variable exposure to practice and coaching on intelligence tests (Wiseman 1954) and to test experience generally

The most important measurement factor making for instability of the IQ are age level changes in the composition of intelligence tests and in the degree of overlap of test content between adjacent age groups (J E Anderson 1939 Bayley 1955) Because infant intelligence scales measure a largely unrelated type of sensorimotor ability instead of the cognitive ability tested at later age levels a child with high genic endowment for abstract intelligence tends to score much closer to the mean on earlier than on later tests Hence he makes a spuriously low score on the initial test and registers a spurious gain on the second test the reverse holds true for the child deficient in abstract intelligence (J E Anderson 1939) Dissimilarity in test content on the other hand is necessary and desirable in instances where genuine developmental change occurs in the organization of intelligence For example intelligence tests should be more highly differentiated at age 15 than at age 5

Just because the genotype remains constant we cannot *assume* that its effects on development necessarily lead to individual constancy in relative rate of growth Since genic factors also determine *normative* fluctuations in rate of cognitive development over the life span they may also conceivably give rise to *intra individual variability* in rate of growth Longitudinal analyses of individual growth curves of intelligence by N Bayley (1940) and E L Cornell and C M Armstrong (1955) are consistent with this interpretation The latter investigators were able to classify most growth curves under three main patterns—a continuous growth curve from age 5 to 18 a step-like curve consisting of alternate spurts and pauses, and a discontinuous curve breaking at puberty and showing either a steeper or more gradual slope thereafter

Environmental factors contribute in two ways to fluctuations in the IQ First, physical and emotional vicissitudes of a transitory nature (illness, emotional trauma, separation from parents, rejection by peers) may impair a child s intelligence test *performance* without basically affecting his cognitive *capacity* Second, radical and sustained changes in cognitive stimulation or motivation may modify actual capacity for intellectual functioning However, as will be pointed out below, significant alterations in IQ of such origin can be anticipated only in young children who are removed from a markedly impoverished to a normally adequate or enriched environment

Personality traits associated with parent attitudes influence the constancy of the IQ "Democratic" homes, encouraging the development of children s independence, tend to be associated with a rising IQ (Baldwin, Kalhorn and Breese 1945, E I Grant, 1939) Gains in IQ are correlated with independence (Sontag Baker, and Nelsen, 1955) and high achievement motivation (Kagan, Sontag, and Baker, 1958), whereas losses in IQ, especially in girls, are correlated with dependence (Sontag Baker, and Nelsen, 1955) The greatest changes in IQ tend to occur in intellectually gifted children (Lindholm, 1964)

## Sex Differences

Sex differences in general intelligence tend to be negligible in magnitude and inconsistent in direction (Terman and Tyler, 1954) The most widely used individual tests of general intelligence—the Revised Stanford Binet Scale and the Wechsler Intelligence Scale for Children—after all, have been so constructed as to eliminate sex differences Most of the obtained differences can be attributed to the fact that the particular tests used are differentially weighted with respect to the various component aspects of intelligence in which boys and girls differ in opposite directions—vocabulary, verbal fluency, rote memory, spatial and numerical abilities (Terman and Tyler, 1954)

Evidence regarding differences in variability also tends to be inconsistent and equivocal These differences, when found, are most marked at the extremes of the distribution, but the operation of variables other than genic patterning role in the development of intelligence Even if it could be held *constant* over individuals it would still play this *active* regulatory role rather than merely constituting a passive field for the unfolding of a trait completely determined by genic factors its effects under such conditions would simply operate in a uniform way for all individuals However since it varies in important ways that affect the development of intelligence it also contributes to inter and intra-cultural variability both in the patterning of intelligence and in the realization of genic potentialities for developing intelligence It determines the extent to which existing genic endowment can be converted into overt functional capacity and helps determine which *particular* components will be selectively emphasized as the latter capacity undergoes differentiation with advancing age

Culture social class and family have many ways of influencing attained level of cognitive development By providing more or less opportunity for training and experience by offering more or less encouragement and stimulation and by selectively valuing and rewarding intellectual attainment the operation of these factors leads to substantial differences in ultimate outcome among individuals with comparable genic potentiality Personality variables of temperamental and environmental origin play a similar role Especially important in this connection are (a) such determinants of *task oriented* motivation as intellectual curiosity activity level and venturesomeness (b) intensity and area of ego-involvement (c) such correlates of ego-enhancement motivation as need for achievement competitiveness responsiveness to prestige incentives level of ego aspiration goal tenacity frustration tolerance and anxiety level and (d) need for volitional and executive independence [7] Intellectually gifted children tend to excel in most of these traits (Lightfoot 1951 Terman and Oden 1959) Although some of the positive relationship between motivational and intellectual superiority can be attributed to their common association with high socioeconomic status or to the better ability of more intelligent children to perceive the characterological ingredients of success it is entirely conceivable that level of motivation *directly* influences extent of actualization of genic potentialities for developing intelligence Independent and competitive children for example tend to show large increases in IQ in the period from 6 to 10 years of age (Sontag and Kagan 1963)

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When overprotecting parents try to keep their children emotionally dependent or when the latter attempt to retain an infantile dependent status failure to develop intellectual competence admirably serves both purposes (Stover 1953) See also L W Sontag C T Baker and V Nelsen (1958) Children from homes characterized by warmth freedom of exploration and acceleratory pressure make the largest gains in IQ (Baldwin Kalhorn and Breese 1945)

### The Problem of Modifiability

Once we grant that the IQ represents a *multiply determined functional capacity* in the development of which experiential and motivational factors play an important regulatory role it is superfluous to inquire whether it can be modified by significant changes in such factors The more relevant questions at this point are the extent of modification that is possible and the conditions under which it occurs The most important limiting factors are (a) irreversible loss in attainable capacity following prolonged failure to actualize genic potentiality (b) diminished plasticity in older children and (c) the crucial role of genic influences in setting absolute as well as relative restrictions on the amount of change that can occur From these considerations it is apparent that significant environmental modification can be anticipated only in early childhood and after correction of serious deprivation It is hardly likely that discriminable changes in IQ will be found following improvement in an environment that is already reasonably adequate from the standpoint of intellectual stimulation and motivation

Before changes in IQ can be validly interpreted as evidence of environmental modification of cognitive capacity it should be obvious that such changes must be reliably greater than fluctuations attributable to *measurement* factors alone Failure to take this consideration into account has led to many unwarranted and exaggerated claims regarding the modifiability of the IQ Hence before we review studies of the effects of such factors as foster home placement continued institutionalization or nursery school attendance on level of intellectual functioning we would do well to consider various nonenvironmental sources of change

First because of very large errors of measurement in infancy and early childhood infant and preschool scales are not even very reliable measures of current intellectual status Many of these errors of measurement lead to underestimation of a given child s actual intelligence in other instances intelligence is overestimated In either case there is a tendency toward regression to the mean upon subsequent testing (statistical regression) Relatively large changes in measured IQ reflective of test unreliability therefore occur irrespective of any concomitant alteration in environment Instability of such origin should certainly not be confused with evidence of genuine plasticity (J F Anderson 1939)

Second because of their emphasis on neuromuscular and sensorimotor functions infant scales do not really measure abstract verbal ability and thus have very little predictive value for later intellectual status Scores on infant scales therefore constitute neither an adequate baseline from which to measure subsequent gains or losses in relative intellectual standing nor an adequate criterion in terms of which infant or preschool subjects may be matched for relative intellectual ability (J E Anderson 1939) Simply on the basis of actual genotypic capacity for abstract cognitive functioning that is *not* measured by the initial test large *spurious* increments and decrements in intelligence are registered in later years For example quite apart from any environmental influence progressive decline in IQ may be anticipated from poorly-endowed orphanage children simply because of their spuriously high scores on infant scales and contrariwise progressive increases in IQ may be anticipated from well-endowed orphanage children simply because their genic potentialities for developing abstract intelligence are underestimated by the infant scales Selective factors that operate in the adoption of orphanage children (greater likelihood of placing brighter better endowed children) may thus account in part for the retention or even improvement of the initial IQ status of adopted children In evaluating the gains associated with a good foster home or nursery school environment it is also important to realize that test disadvantage (relative unfamiliarity with specific test material or indifferent test motivation) is more likely to occur in an impoverished than in a reasonably adequate environment

In appraising studies of attempted modification of the IQ attention should also be paid to the principle to filial regression[8] and to the possibility of genically-oriented *intraindividual variation* in rate of growth Thus quite independently of any errors of measurement or of any change in the environment the children of intellectually dull individuals tend to score higher than their parents on intelligence tests and many children also show considerable spontaneous fluctuation in relative status during their growth careers

### *Deprivation and Enrichment*

Because of the great practical importance of the possibility of modifying intellectual capacity a voluminous and highly controversial literature dealing with the effects of environmental deprivation and enrichment has arisen during the past three decades Interpretation of this literature is extremely difficult since very few studies have been sufficiently well controlled to exclude many nonenvironmental sources of measured change in IQ In general the weight of the evidence suggests two tentative conclusions First serious and prolonged deprivation especially during late infancy and the preschool years seems capable of inflicting *permanent* damage on intellectual growth Second enrichment of the existing environment can effect substantial improvement of intellectual status only in young children with a prior history of serious deprivation

[8] The tendency for children of parents manifesting deviant traits to score closer to the mean than their parents with respect to these traits

EFFECTS OF DEPRIVATION We have already considered evidence of the immediate and long term detrimental effects of early cognitive deprivation on sensori motor, language, and intellectual development Such studies are obviously vulnerable to criticism on the grounds of the unreliability of the infant scales employed and on the basis of inadequate matching of control and experimental groups (Pinneau, 1955) Unqualified dismissal of these findings, on the other hand, is unwarranted when they are considered in the larger context of related evidence In the first place, the very grossness of the findings, and their consistent replication by many independent investigators in different parts of the world compensate, in part, for their methodological weaknesses Second, they are consistent with observational and clinical data on the children concerned, with studies of animal deprivation, and with studies of older children growing up in orphanages and in depressed rural areas

It seems highly probable as stated previously, that the longer children remain in substandard environmental conditions, for example, orphanages (Skeels and Fillmore 1937, Skeels, and others 1938) or with mentally retarded mothers (Speer, 1940), the progressively lower their IQ s become in comparison with the IQ s of comparable children reared in more favorable environments Providing greater credibility for these findings are reports of progressive decline in the intelligence test scores of isolated mountain and canalboat children who also grow up in intellectually nonstimulating and unchallenging environments (Asher, 1935, H Gordon, 1923, Sherman and Key, 1932, Wheeler, 1942) The facilitating effect of migration to and prolonged residence in the North on the IQ s of Southern Negro children has already been considered In general, prolonged exposure to extremely deprived environments depresses the IQ about 20 points—more during the preschool years than in older children (Bloom 1964a) However, some of the loss registered by children who remain in the less favorable environments is attributable (a) to relatively poor genic endowment (as a result of *selective* adoption or migration) which for psychometric reasons, can *first* be manifested in *later* scores on tests of intelligence, and (b) to progressively greater test disadvantage as intelligence tests place increasing emphasis on verbal abilities Further, despite the so-called leveling effect of the institutional environment variability in intelligence scores does *not* decline with advancing age (J E Anderson 1939), thereby demonstrating the prepotent influence of original differences in genic endowment

When orphanage children from relatively poor hereditary and social backgrounds are placed at an early age in superior foster homes, there is evidence of either improvement in IQ (Freeman Holzinger, and Mitchell, 1928) or of maintenance of an above average rate of intellectual growth that is sustained over many years (Skodak 1939 Skodak and Skeels 1949) Although *part* of these changes may reflect the influence of an improved en at successive age levels increases By school age parent child correlations are in the neighborhood of 50 (Burks 1928 Conrad and Jones 1940 Leahy 1935) However since the existing degree of relationship could reflect the influence of either heredity or environment these data shed little light on the nature nurture problem Nevertheless two clues point to the greater weight of heredity If environment were a highly significant factor we would expect that (a) since mothers bear the major burden of child rearing in our society the IQ of children would be more highly correlated with mothers than with fathers IQ and (b) since siblings share a more uniform developmental environment with each other than with their parents inter sibling resemblance would be greater than parent child resemblance Since available data (Conrad and Jones 1940) confirm neither hypothesis the environmentalist position is accordingly weakened

More crucial evidence on the nature nurture problem is provided by comparison of foster parent foster child and true parent true child resemblances in IQ Foster children share only their foster parents environment whereas true children share both heredity and environment with their parents In the foster home situation where the genic basis of resemblance is removed parent child correlations (Burks 1928 Leahy 1935) are considerably lower[10] (approximately 20) than in the natural home situation (approximately 50) Similarly intra pair differences between children whose *own* fathers are at opposite extremes of the occupational hierarchy are markedly higher than intra pair differences between children whose *foster* fathers are in comparable positions (Burks 1938) It seems therefore that the greater part of the variance in children s IQ s is attributable to genic rather than to environmental factors This conclusion is consistent with findings (Skodak 1939 Skodak and Skeels 1949) that whereas the IQ of foster children is only negligibly related to their foster parents educational status it is moderately correlated at school age with true mothers educational status ( 35) and IQ ( 40) The latter correlation is almost as high as that between children and true parents who are domiciled together

### *Sibling and Twin Resemblance*

We have already noted that the absence of significant differences between the parent child and inter sibling correlations in IQ lends support to the hereditarian position Other related findings point in the same direction (a) the resemblance between true siblings reared in the same home is

[10] Some of the resemblance between children and foster parents may also reflect the influence of selective adoption — the tendency to match foster and true parents in terms of IQ and occupational background (Conrad and Jones 1940 Leahy 1935)

substantially greater than the resemblance between foster siblings (Freeman, *et al*, 1928), (b) similarity with respect to age and sex does not increase inter sibling resemblance in IQ as one might expect if environmental factors exercised considerable weight (H E Jones, 1954), (c) resemblances between foster siblings are no greater than foster parent foster child resemblances despite greater similarity in environment (Burks, 1928, Freeman, Holzinger, and Mitchell, 1928, Leahy, 1935), (d) separation of siblings does not lower inter sibling correlations (H E Jones, 1954), and (e) when *interfamilial* environmental variability is eliminated, as in the orphanage situation, neither the resemblance between sibling pairs nor the degree of variability in IQ scores is correspondingly reduced (H E Jones, 1954)

Comparative studies of identical and fraternal twins shed more light on the nature nurture problem inasmuch as identical twins have approximately identical genotypes, whereas fraternal twins are genically no more similar than ordinary siblings Here, too the findings give little comfort to environmentalists Identical twins are markedly more similar in IQ than fraternal twins (correlations of 80 to 90 as against 50 to 60), and even when identical twins are separated differences in IQ are generally smaller than among fraternal twins reared together (Burt, 1958, Newman, Freeman, and Holzinger, 1937, Woodworth, 1941) Sizeable differences in the IQ s of separated identical twins are only found when their educational backgrounds are highly dissimilar On the basis of these small differences in IQ when heredity is held constant, while the usual degree of environmental variability prevails R S Woodworth concludes that the differences found among the children of an ordinary community are not accounted for, except in small measure, by differences in home and schooling (Woodworth, 1941)

### *Social Class Differences*

Prior to 18 months of age, zero or low negative correlations are found between scores on infant intelligence scales and various socioeconomic factors (Bayley and Jones, 1937) Thereafter the magnitude of correlational indices increases rapidly, and at school age varies between 3 and 5 for different educational, occupational, and economic criteria of social class status (Bayley and Jones 1937) The early absence of relationship simply indicates that intelligence tests cannot possibly measure the same cognitive abilities during infancy as in later years The increasing correspondence between IQ and socioeconomic variables as degree of test overlap increases, may reflect either the cumulative impact of environmental influences or an increasing manifestation of hereditary potentialities (Bayley and Jones 1937)

Beginning with the preschool period, a range of about 20 points separates children of the highest and lowest socioeconomic groups (Deutsch and Brown 1964 Terman and Merrill 1937) The relationship between children s relative intellectual status and father s position in the occupational hierarchy is practically linear (Deutsch and Brown 1964 Terman and Merrill 1937) and in correlational terms varies between 20 and 43 for different tests of intelligence (Eells and Davis 1951) Upper socioeconomic groups also contribute a disproportionately large number of intellectually gifted and a disproportionately small number of mentally retarded children to the total population (McGehee and Lewis 1942) These relationships refer of course to group averages since differences within an occupational group are actually much larger than differences between the means of various groups Although social class differences are greatest in the area of verbal abilities (Eells and Davis 1951) significant differences have also been found for all of L L Thurstone s primary mental abilities (Havighurst and Breese 1947) as well as for other nonverbal tests

The interpretation of these social class differences in intelligence has led to much heated controversy between hereditarians and environmentalists Actually three different kinds of explanations based respectively on measurement environmental and genic factors seem equally plausible but the evidence currently available is not sufficiently definitive to establish their relative weight The measurement argument stems from a certain amount of middle-class bias in the construction of most intelligence tests This creates test disadvantage for the lower class child and results in an underestimate of his true level of cognitive functioning In order to derive a valid and fair estimate of intellectual capacity from test performance it is necessary that (a) specific test items be based on experiences and symbols that are equally available and familiar to individuals from all social class strata and (b) test materials arouse comparable degrees of interest and motivation in persons of different social-class origin (A Davis 1948 Eells and Davis 1951)

Most present-day tests are heavily weighted with specific items that are more familiar and appealing to middle than lower class children and with the kinds of *cognitive functions* (vocabulary linguistic skills) that are particularly emphasized in middle class environments[11] The tests are thus unfair in the sense that their specific item content does not give the lower-class child a fair opportunity to demonstrate his *attained* level of cognitive capacity But since intelligence tests do not purport to measure either genic potentialities in themselves or noncognitive abilities they are unfair neither because they fail to measure level of functioning in those noncognitive abilities in which lower-class children excel nor because the

[11] As noted above however large socioeconomic differences also prevail for other nonverbal tests

middle class environment is experientially or motivationally more propitious for the development of native cognitive endowment The very fact that these tests favor middle class children demonstrates that the environment *can* operate selectively to develop certain aspects of intellectual endowment This conclusion is compatible with the findings that intelligence becomes more and more differentiated with increasing age (Garrett, Bryan, and Perl, 1935, Segel, 1948) and that sex differences in many specific intellectual functions increase or reverse themselves as children grow older (Kuhlen, 1952)

Acceptance of the test bias explanation of social class differences by no means rules out the genic or environmental interpretations [12] Insofar as environmental factors contribute to some of the variance in intelligence test scores, it would not be unreasonable to expect that differential social class levels of stimulation and motivation affect extent of *actualization* of genic endowment Evidence for this type of mediation of environmental influence comes from the finding that children's IQ s are more highly cor related with parents education than with the economic status of their homes (Loevinger, 1940) Social class environment also *selectively* influences the differentiation of intellectual and other abilities as shown by the fact that middle class children are superior to their lower class contemporaries in both verbal *and* mechanical abilities at age 10, but are superior only in the former ability at age 16 The environmentalist position is weakened, however, by the existence of large social class differences in the *preschool* period (Terman and Merrill, 1937), by the failure of social class differentials to increase with advancing age (Shuttleworth, 1940), and by the significantly greater correlation of foster children s IQ s with *true* mothers' than with *foster* parents educational status (Skodak, 1939, Skodak and Skeels, 1949)

The hereditarian position rests on the assumption that (a) since there is indisputable evidence of substantial genic contribution to individual differences in IQ and (b) since more intelligent persons on the average, choose and are selectively successful in the intellectually more demanding occupations it is reasonable to ascribe at least part of the consistently ob tained social class differences in IQ to genic variability in cognitive potential The tendency for more highly endowed individuals to reach the higher rungs of the occupational ladder is especially evident in a society character ized by a fair degree of social mobility, and since such persons also tend to marry at their own intellectual level (H E Jones 1954), their offspring

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[12] The finding that approximately the same social class differentials appear on the Davis-Eells culture fair test as on the Kuhlmann Finch test (Coleman and Ward 1955) casts doubt on the claim that the Davis-Eells test is culturally more fair but does not necessarily invalidate the test bias hypothesis of social class differences

acquire a genic advantage from both parents Although logically tenable it is understandably difficult to put this hypothesis to empirical test It is supported in part by the applicability of the principle of filial regression to social class differences that is children of professional parents tend to have a lower IQ than their parents whereas the reverse holds true for children of unskilled laborers (Outhit 1933)

### *Urban Rural Differences*

The mean IQ of rural children is consistently lower than that of urban children and also tends to diminish with increasing age (Asher 1935 Chapanis and Williams 1945 Wheeler 1942) As in the case of lower-class children this inferiority is most marked on verbal and speed items and is undoubtedly attributable in part to test bias (H E Jones 1954) Intelligence scales are typically devised by urban reared psychologists and are validated on urban school children However since rural children also do more poorly on items presenting no special experiential or motivational handicap it is unwarranted to ascribe *all* urban rural differences to test disadvantage Equally plausible are explanations based either on the cumulative impact of a low level of intellectual stimulation or on the selective migration of more highly-endowed individuals to urban areas

### *Intelligence and Family Size*

In most investigations of the relationship between IQ and number of siblings in the family a negative correlation of 2 to 3 is reported (Anastasi 19o6) Since there is no evidence whatsoever of any intrinsic relationship between IQ and procreative ability only two other explanations seem plausible First the presence of a large number of children in the family may reduce the amount of cognitive stimulation available for each child The per capita expenditure on education recreation housing medical care and so forth is ordinarily lower when there are many siblings in the family and even more important in terms of language development the extent of parent-child contact is restricted (Nisbet 19o3) Second IQ and size of family are indirectly related by virtue of a common relationship to social class status—persons in the upper economic strata tend to have both a higher IQ and to raise relatively small families

To the extent that the intellectual superiority of their children is a function of either measurement or environmental factors the inverse relationship between parents fertility and social-class status obviously has no implications for eugenics However insofar as persons in the upper occupational strata may be presumed to possess a superior genic endowment with respect to cognitive capacity their relatively low fertility rate may be expected over the course of many generations (in the absence of compensatory genic factors) to contribute to a national decline in the genotypic basis of intelligence

In spite of the ominous prediction predicated on this line of reasoning there is some evidence of a slight but significant gain in the mean IQ of Scottish children from 1932 to 1947 (Scottish Council for Research in Education 1953) Furthermore despite the tremendous increase in high school enrollment from 1916 to 1940 with a corresponding elimination of the intellectual selectivity that formerly operated there has been no drop in the mean IQ of the American high school population (Finch 1946) The maintenance of phenotypic levels of intelligence under these circumstances can be explained perhaps by (a) compensatory changes in such environmental determinants of intelligence as the general standard of public education (b) greater test sophistication on the part of children and (c) a trend in recent years toward a higher birth rate among upper socioeconomic groups (Anastasi 1956)

## Intelligence as a Predictor of Academic Achievement

Academic achievement or success in various subject matter fields generally correlates about 0 5 with intelligence or academic aptitude test scores Some components of academic aptitude tests such as vocabulary (Locke 1963) reasoning and information (J W French 1964) have more predictive value than others for scholastic achievement Intelligence test scores are also negatively correlated with drop-out rate from high school (Dillon 1949) Specific aptitude tests such as quantitative ability or numerical reasoning naturally correlate much more highly than IQ with such related subject matter fields as mathematics *In any case the predictive value* of academic aptitude scores varies greatly with such factors as sex (Locke 1963 McGuire 1961) and type of community (McGuire 1961)

Low intelligence can apparently be compensated for in part at least by grading learning tasks to pupils current achievement levels When this is done for arithmetic materials no significant differences are found among children of low average and high IQ in learning retention and transfer (Klausmeier and Check 1962 Klausmeier and Feldhusen 1959) Longer exposure times can similarly compensate for the effects of low intelligence on level of perceptual organization (Allen Tyrrel Schulz and Koons 1958) Considerable evidence generally supports the proposition that instructional aides organizing devices and superior textual materials differentially benefit the duller and initially less knowledgeable as opposed to the brighter and initially more knowledgeable student Correlations be tween scholastic aptitude and subject matter achievement tests tend to decline consistently from the beginning to the end of the course in question. However, this same trend toward progressively decreasing discrepancies between the achievement levels of the bright and dull does not necessarily prevail when pupils are permitted to learn at their own rate of speed.

Intelligence level also influences *qualitative* aspects of achievement. It affects the rate of acquiring learning sets (N. R. Ellis, 1958; House and Zeaman, 1959; Kaufman and Peterson, 1958; Stevenson and Swartz, 1958), performance on structured categorization tasks (W. E. Stephens, 1964), and the strategy of problem solving (Battig, 1957; Klausmeier and Loughlin, 1961). High IQ subjects are more likely to correct mistakes independently, to verify solutions, to use a logical approach, to employ a more efficient method, and to be persistent.

It has been argued, with some validity, that since achievement tests take into account both motivation in past learning tasks, as well as scholastic aptitude, they are more highly predictive of future achievement than are intelligence tests. Thus grades in algebra I correlate more highly with success in algebra II than does either general scholastic aptitude or freshman grade point average (Sommerfeld and Tracy, 1961), and high school grade point average predicts academic achievement at the university level better than do scholastic aptitude scores (Endler and Steinberg, 1963). Some studies (Getzels and Jackson, 1962; Torrance, 1963) suggest that so-called tests of creativity correlate just as highly with academic achievement as do intelligence tests. A methodologically more definitive study by Flescher (1963), however, failed to confirm this finding and did not demonstrate the existence of any significant generality of function among various tests of creativity.

Why is the relationship between scholastic aptitude and academic achievement only moderate in degree? For one thing, measures of neither variable are completely reliable or valid. More important, however, is the operation of other relevant factors, such as motivation, interests, personality traits, adjustment, and family, peer group, social class, and cultural influences that affect the degree to which existing scholastic aptitude is actualized in the form of academic achievement. Comparison of educationally successful and unsuccessful gifted children reveals that the successful have better study habits, exhibit more self-control and "compensatory" as contrasted to "protective" ego mechanisms, have more realistic levels of aspiration, and excel in such personality traits as dependability, self-reliance, ambition, investigativeness, and persistence (W. D. Lewis, 1941; Locke, 1963; Regensburg, 1931; P. S. Sears, 1940; Terman and Oden, 1949). Differences between students who complete one curriculum in college and those who complete another are also greater in interests than in abilities (J. W. French, 1961; R. G. King, 1958). Parental attitudes, aspirations, and financial resources, as well as students' degree of insight into their own abilities, are highly related to whether or not high school graduates will attend and re main in college (Kahl, 1953, Parsons, 1959) Scholastic aptitude scores and rank in high school graduating class have more predictive value for boys than for girls with respect to entrance into and graduation from college (Kahl, 1953), thus confirming the greater value which our culture places on male vocational achievement

As a group, intellectually superior individuals tend to gravitate toward professional occupations, to be more successful vocationally, and to experi ence less unemployment (Terman and Oden, 1949) *Within* a group of gifted children (IQ s over 140) however, the adults successful twenty five years later were, as children, more integrated in goal structure, more self confident, and more persevering than the unsuccessful adults even though the two groups were quite evenly matched in intelligence We can conclude, there fore, that better than average intelligence is undoubtedly a vocational asset, but given this degree of intellectual ability, unusual success in a vocation is more a function of special talent or creativity and of various personality traits, than of extremely high general intelligence There is no evidence that would indicate that creativity and general intelligence are positively related beyond this critical minimal point

### *Under- and Overachievement*

Considering the methodological hazards involved in the identification of under and overachievers (students who achieve less or more than could could be anticipated by their scholastic aptitude scores) and the only mod erate degree of relationship between academic aptitude and school achieve ment, it is somewhat questionable what practical utility these widely used concepts have for educational practice (R L Thorndike 1961, 1963) In any case underachievers, as contrasted to achievers tend to be characterized by more withdrawal behavior and by less social, work oriented interaction with peers (Perkins 1965) by more negative self concepts (Shaw, Edson, and Bell, 1960), by higher mechanical and artistic interests and by lower verbal and mathematical aptitude (Frankel, 1960), and by membership in lower status occupational groups (Frankel, 1960)

The underachievement syndrome starts as early as the third grade in the case of boys but not until the ninth grade in the case of girls (Shaw and McCuen 1960) Bright underachievers in college have lower and less clearly defined ' real life (academic and vocational) goals than bright nor mal achievers (Todd Terrell, and Frank, 1962), but the reverse paradox ically appears to be true when the achievement needs of over and normally achieving college students are assessed by thematically induced achievement imagery (Cole and others 1962) In both studies, these differential findings apply only to males Differentially high thematically induced achievement imagery is elicited for achieving versus underachieving adolescent girls only in achievement-oriented conditions and in relation to female (as opposed to male) figures (Lesser, Krawitz, and Packard, 1963) The authors suggest that achieving girls tend to accept academic achievement as appropriate for females whereas the underachieving girls do not

Chapter 7

# PROVIDING FOR INDIVIDUAL DIFFERENCES IN INTELLECTUAL ABILITY

PREVIOUS DISCUSSION of both developmental and particularized (subject matter background) readiness for learning, as well as of general intelligence and particular scholastic aptitudes, has made it abundantly clear that a wide range of individual differences exists at any given age level of pupils These differences are expressed in general (over all) mode of cognitive functioning, in approach to problem solving, in subject matter sophistication, in general level of intelligence, in specific academic aptitudes, in motivation for learning, in intellectual curiosity, in self-critical ability, in need for precise meanings and integrated knowledge, and in ability to think independently, critically, and creatively Obviously, therefore, no realistic system of teaching can afford to overlook such differences Hence, individualization of teaching must necessarily constitute one of the primary goals of instruction As far as possible, the individual student, rather than the class as a whole, must become the working unit in the instructional process Each child must be challenged at a level appropriate to his potentialities, and encouraged to learn at a commensurate pace

The need for individualization of instruction is also implicit in the school s responsibility to develop problem-solving ability, to encourage intellectual curiosity and initiative, to promote independent, original, and critical thinking, and to stimulate pupils' desire and ability to learn on their own As pointed out above, these educational objectives are neither incompatible with meaningful reception learning nor inconsistent with the primary responsibility of the school for organizing and directing the curriculum Neither do they constitute the primary goals of education nor the principal means of transmitting subject matter knowledge

In general, two principal approaches have been taken to the problem of individual differences in pupils—ability grouping and individualized instruction These approaches are by no means mutually exclusive Obviously, some form of group instruction is inevitable because *completely* individualized instruction is not economically feasible Neither is it necessary, desirable, nor efficient for many educational purposes Furthermore, learning in a group context has many *positive* advantages of its own—both from the standpoint of cognitive development and from the standpoint of the child s emotional and social needs Evidently then some form of compromise must be found between grouping and individualization

## Advantages and Disadvantages of Grouping

Ability grouping purportedly takes account of individual differences in two ways First by bringing together children of similar ability, it permits the teacher to gear the level and method of instruction to the *particular* level of ability prevailing in the group The teacher no longer has to accommodate to the hypothetical ability level of the *average* child as the fairest approximation of the group s ability Thus she can avoid a pace and level of instruction that is too difficult for the dull pupil and too easy for the bright pupil Second when pupils of comparable ability interact in the learning process, 'social facilitation of learning presumably occurs by making it possible for bright children to be stimulated by their intellectual peers This latter advantage however has never been unequivocally demonstrated H Gurnee (1962) for example found group learning to be superior to individual learning not because of social facilitation but because it provides an opportunity for less successful group members to imitate their more successful classmates If this is the case, it is evident that the possibilities for such imitation would be even greater in a heterogeneous group H J Klausmeier, W Wiersma and C W Harris (1963) also discovered that although pupils working in small groups learn better initially, they do less well than individual pupils on tests of transfer The research evidence (Drews 1959 Fleming 1959, Herrick 1960 Spitzer, 1954) generally shows that grouping in small homogeneous units does not in and of itself, lead to superior learning outcomes

On the other hand there are many disadvantages to grouping First whichever criterion is chosen as the basis of grouping—chronological age, mental age social maturity, specific scholastic aptitude, or subject matter sophistication in a particular discipline—group heterogeneity with respect to most *other* factors is almost inevitably bound to increase Second grouping on the basis of a composite intelligence test score becomes progressively less efficient for purposes of individualization as children s cognitive and scholastic aptitudes become increasingly more differentiated or less highly intercorrelated with increasing age Third, heterogeneity itself has positive values It enables the child better to adjust to the wide variety of ability levels *he meets outside the school environment It also provides intellectual* stimulation and models for imitation for the dull child, as well as gives the brighter pupil an opportunity to clarify and consolidate his understanding of concepts by explaining them to his less precocious classmates Fourth, ability grouping tends to stigmatize the dull and to generate arrogance and conceit in the bright This disadvantage, however, has undoubtedly been overemphasized Children who do not measure up to their contemporaries almost inevitably appreciate their inferiority and suffer self-depreciation with or without ability grouping It can be argued further that more explicit realization by a child of his relative profile of abilities promotes a more realistic self-concept and level of aspiration

Last, and perhaps most important, is the fact that individualization is accomplished more effectively (while simultaneously preserving the advantages of group instruction) by bringing together children of *diverse* ability levels in one class, and by arranging for each pupil to progress at his *own* pace by means of varying the amount, nature, and difficulty level of the material he learns In this way, differences in motivation, interest, and curiosity, as well as ability, are taken into account M Montessori (Rambusch, 1962) discovered long ago that when preschool children are confronted with learning tasks that both interest them and are commensurate with their developmental level of readiness, their attention span is greatly increased, and they manifest much more intellectual curiosity and persistence than is commonly realized

## *Differential Ability Grouping*

If ability grouping is practiced at all, it should undoubtedly be based on the results of differential aptitude tests or on particularized measures of subject matter achievement (for instance, mathematics, science, language arts) In accordance with this point of view, a given pupil is placed in those particular sections of various school subjects that correspond to his relative aptitude or achievement standing in the disciplines in question Many different kinds of administrative arrangements are compatible with this principle of grouping One may set up separate sections of a given course or several subgroups within a given section The Dual Progress Plan (Stoddard, 1961) places each pupil half of each day in his homeroom with his agemates and homeroom *teacher for instruction in the* cultural imperatives " The rest of the day is devoted to various special subjects in which pupils are taught by specialist teachers in separate classes grouped to assure relative homogeneity of ability

The Trump Plan (Trump and Baynham, 1961) involves greater flexibility of administrative arrangements in which the standard high school class of thirty is replaced by some very large demonstration and lecture classes (utilizing, where advisable, either educational television or specialist "master teachers"), some small discussion groups, and much self-instruction with programmed learning devices. In any case, whatever the administrative pattern, differential ability grouping implies specialist teachers in the various specialty subjects, as well as teaching methods and instructional demands that are appropriate for the existing developmental readiness and subject matter sophistication of the groups in question.

### *Individualization*

Complementary to differential ability grouping is the provision of individualized instruction (differential assignments) within each group. For the greater part of the school day, each student works independently at his own optimal pace with sequentially organized programmed materials providing for self-testing. Such self-instruction is more efficient for most aspects of subject-matter learning than is class instruction (Milton, 1962). As will be pointed out below, programmed instruction does not necessarily involve the short-frame and small step-size format characteristic of the typical teaching machine, but does provide for organizing, unifying, and explanatory ideas, for unusual lucidity of presentation, for early confirmation, clarification, and correction of newly acquired concepts and principles, for consolidation or necessary overlearning of existing knowledge before new material is presented, and for sequential organization of subject matter.

On theoretical grounds it seems rather self-evident that individualized instruction should be incomparably more efficient than instruction in groups for most aspects of subject-matter learning. When instruction is geared to the individual pupil's general level of sophistication in a particular discipline, to his mastery of relevant antecedent concepts and principles, to his particular preconceptions and misconceptions, to his general and specific intellectual aptitudes, to the level of abstraction at which he operates, to his idiosyncratic cognitive style and relevant personality attributes, to salient aspects of his progress in mastering a current learning task (for example, consolidation, precision and clarity of new meanings), and to a pace of presentation that is comfortable for him, it necessarily follows that learning outcomes should be superior to those that eventuate when instruction is geared to a hypothetical set of characteristics and requirements reflective of the mean pupil in a group. Surprisingly enough, however, empirical testing and confirmation of this proposition, apart from one study by Milton (1962), have been almost totally neglected by educators and educational psychologists In view of the tremendous emphasis that members of these professions have placed on individualized instruction [1] at least in the realm of theory one might have anticipated more concern with providing greater empirical support for its efficacy

One of the difficulties here lies in the very narrow conception of what is meant by the individualization of instruction Until relatively recently the only variables taken into account were scores on a general or differential test of intellectual ability Similarly when programmed instruction enthusiasts entered the field of individualized instruction they focused their attention myopically on practice and reinforcement aspects of the current learning task Ericksen (1967) has stated the case very well in demonstrating that for the most part instructional aids have contributed very little thus far to the goal of individualized instruction

Another important research consideration in this context is the need for testing the separate effects of particular dimensions of individualization *and the interactions among them as opposed to performing global studies* in which the separate contributions of different variables are not conceptualized identified or measured This of course does not preclude but rather highlights the desirability of multivariate research designs

The careful sequential arrangement and gradation of difficulty characteristic of programmed instruction maintains subject matter readiness by insuring that each attained increment in learning serves as an appropriate foundation or anchoring post for the learning and retention of subsequent items in the ordered sequence This is accomplished by optimal self pacing *by frequent testing and the provision of feedback and by furnishing adequately* spaced reviews and opportunity for differential practice of the more difficult components of a task Properly programmed materials also take into account the principles of progressive differentiation and integrative reconciliation as implemented in the use of appropriate advance organizers

Those aspects of instruction in which knowledge is less well defined and in which the acquisition of independent and critical thinking ability is a major goal obviously require more class discussion and direct teacher participation But teachers have more time to devote to these latter objectives *to cultivate a questioning attitude toward established knowledge and to* focus on the discovery aspects of acquiring new knowledge if the more

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[1] It should be noted here that individualized instruction is not synonymous with self instruction Individualized instruction is sometimes best accomplished in a group setting as for example in the learning of those kinds of subject matter calling for group discussion (see below) It may also be teacher as well as self directed Ungraded classes imply both self instruction and individualized instruction in a group context

stable and substantive aspects of a discipline are learned individually by means of programmed instruction

Individualization can be implemented better by specialist teachers who are more conversant both with subject matter content and with different methods of presentation than are general elementary school teachers To be effective individualization also presupposes continuity between the different levels of instruction to which a child is successively exposed (elementary school junior and senior high school and university) The benefits of individualization in elementary school for example are largely wasted if a bright pupil who has already mastered most seventh-grade work as a sixth-grader is placed in an undifferentiated and nonindividualized seventh grade junior high school class

The concept of the non-graded school (Goodlad and Anderson 1959) combines both an extreme emphasis on individualization and acceptance of learning in a group context First proposed by Montessori (Rambusch 1962) it permits each child to master the curriculum at his own individual rate of speed in a social environment consisting of children of varying ages It presupposes the availability of a wide range of programmed materials and of high teacher pupil ratio envisages the use of older children as emulatory and learning models for their less advanced peers and avoids the stigmatization of nonpromotion

COMPUTER ASSISTED INSTRUCTION The highly complex logistical task of individualizing instruction for each pupil in terms of his differential abilities and aptitudes cognitive style personality traits existing preconceptions and current performance is rendered much more manageable with the assistance of computerized programming The computer can not only be used to select the appropriate content and sequence of material but is also invaluable for record keeping monitoring pacing simulation of problem solving and laboratory situations and for the generation of instructional material At the present time however particularly when the necessary software (for example empirically validated principles of instructional programming tested programs for particular courses of study) is lacking it is not economically feasible for general use in the schools It is also questionable whether the undoubted advantages it offers with respect to the individualization of instruction are that much greater than those inherent in the use of appropriate textbooks enrichment materials frequent testing and feedback and teacher-directed self instruction as to warrant the tremendous capital outlay involved In any case as suggested above computer assisted instruction cannot constitute a complete and self-contained program of individualization since it does not provide for pupil pupil and pupil teacher interaction

## Nonpromotion

Nonpromotion constitutes an attempt at homogenous grouping by withholding progression to the next higher grade from the extremely low achiever Theoretically, it provides a necessary and desirable second opportunity for mastering the same material that the pupil was not able to learn the first time it was presented during the course of a given year or semester In practice, however, the repeater makes less academic progress than the promoted child of comparable ability and achievement (Goodlad, 1952) Although some low achievers do profit from repetition, more of them actually do worse on achievement tests a year later than immediately after failing the grade in question It is not repetition *itself* that has these damaging effects, but rather the stigma of nonpromotion, the impairment of morale, and the exposure to the same inappropriate methods that previously led to failure It is true that the promoted nonachiever is maladjusted and cannot ' keep up in the new class, but he actually does worse by remaining a second time in the same class—in terms of his school work, his self confidence, and his acceptance by peers (Goodlad, 1952, Segel, 1951) On the other hand, unearned promotions tend to generate unrealistic attitudes toward and expectations about, the general relationship between achievement and reward found in adult life

All of this argues less for a policy of 'social promotion than it does for more imaginative ways of teaching subject matter to pupils who are unable to learn adequately when taught by more conventional methods Most nonpromoted children come from culturally deprived homes (Hall and Demarest 1958) Programmed instruction in nongraded classes would seem to provide an ideal solution

## The Academically Gifted

### Enrichment or Acceleration

Individualization in the case of pupils with high intelligence or scholastic aptitude scores generally takes one of two forms Advocates of *enrichment*—the provision of more advanced difficult, or supplementary school work to such pupils while keeping them with their chronological and social peers—argue that this procedure avoids social maladjustment among the gifted equips them better to adapt to persons of all ability levels in later life and enables them to stimulate their duller agemates Enrichment is typically accomplished by means of ability grouping by individualizing instruction within a given class or by segregating gifted children in special schools Proponents of *acceleration*, on the other hand, point out that under present educational conditions it is very difficult for a busy teacher to enrich instruction adequately for gifted pupils (Gallagher and Lucito, 1961), that enrichment usually involves drawing upon subject matter materials from the next higher level of instruction thereby creating problems of boredom and loss of interest when the pupil reaches that level, that special schools often generate unwholesome attitudes of conceit and superiority, as well as isolate the gifted from average children (thereby depriving the latter of necessary social experience and the former of desirable intellectual stimulation) and, most important, that acceleration *itself* has many positive advantages for pupils planning on professional careers

Acceleration can be implemented in many different ways by early admission to kindergarten and college by double promotion, by admission to college with advanced standing and by such means of concentrating instruction as lengthening the school year completing two years of work in one, and more rapid self pacing in ungraded classes The latter procedures avoid the hazard of possibly missing certain important learnings that are essential in sequentially organized curriculums Early admission to kindergarten also presents the disadvantage that only the affluent can afford private schools or the cost of individual intelligence testing and that IQ s at age 4 tend to be both unreliable and to have little predictive value for later academic achievement

In general reviews of acceleration procedures (Shannon, 1957) indicate that they do not handicap the gifted child either socially, emotionally, or in terms of academic accomplishment Children who are admitted at an early age to kindergarten (Worcester, 1956) or who are accelerated from second to fourth grade after a five week summer session (Klausmeier, 1963), do as well or better academically in the later grades than other pupils are just as well adjusted emotionally and socially, are accepted just as readily by their classmates, and are most likely to go on to college (Pressey, 1965) Similarly students who enter college at an early age tend to make better grades are more likely to graduate and go on to advanced study, manifest fewer disciplinary problems and tend to be more successful in their careers (Fund for the Advancement of Education, 1957, Pressey, 1962c, Terman and Oden, 1949) M Meister (1956) found that high-school students who enter college with advanced standing or who pass advanced placement examinations do as well as regular students in their freshman year

Probably the best argument for acceleration of academically gifted pupils is the long period of academic training required today for all professions. Acceleration helps avoid the abnormal prolongation of economic dependence and sub-adulthood as well as the undesirable postponement of marriage that often accompany such training Early entrance into a professional career is also important from the standpoint of self actualization and the advancement of knowledge It has been shown that because of such factors as health, stamina, motivation interest, and freshness of outlook, research and scholarly productivity are higher during the early adult years than at any other time of life (Lehman, 1964, Pressey, 1962c)

## The Mentally Retarded

The proper educational handling and teaching of mentally retarded children are highly technical subjects and ordinarily require special training The major educational decision affecting such children is whether to place them in special classes or to admit them to regular, ability grouped classes The latter procedure probably provides them with greater intellectual stimulation and broader social experience, but neither gives them the benefit of specially trained teachers nor protects them from social rejection by their peers (Johnson and Kirk, 1950, R V Miller, 1956) The final decision hinges upon such factors as the type of curriculum and methods of instruction available in the regular classes, the retardate s ability level and adaptive capacity, and the attitudes and resourcefulness of the teachers in question (Dunn, 1960) The typical classroom teacher is more likely to have contact with culturally deprived than with mentally retarded children

## The Culturally Deprived

The hypothesis of cumulative developmental deficit, invoked above to explain the irreversible effects of cultural deprivation implicitly assumes the *continued* operation of a learning environment whose stimulating value remains average or below average during the crucial formative years of childhood *Hence, despite the twin limiting effects in disadvantaged pupils* of (a) attained deficit in intellectual development and (b) increasing differentiation of intelligence on subsequent responsiveness to cognitive stimulation, it is still consistent with the above theoretical analysis to hypothesize that an *optimal* learning environment could arrest and even reverse *in part* the existing degree of retardation [2] Such an environment must obviously be adequately stimulating, must be specially geared to the deprived individual s particular level of readiness in each subject matter

[2] As previously pointed out we still lack firm evidence regarding the effects of an optimal learning environment on the intellectual development of culturally deprived elementary school and adolescent pupils In any case it has already been conceded that irrespective of later enrichment efforts *some* of the intellectual retardation attributable to cultural deprivation *is* irreversible in older children

area and intellectual skill as well as to his over all level of cognitive maturity and presupposes much individualized attention and guided remedial effort

This, of course, is a far cry from the kind of school learning environment that culturally deprived children typically enjoy In actual practice their existing intellectual deficit is usually compounded by the fact that not only are they less able than their peers to profit from appropriate new learning experiences, but they are also usually overwhelmed by exposure to learning tasks that exceed by far their prevailing level of cognitive readiness Hence, since they do not function at the required level of cognitive maturity and do not possess the necessary background of knowledge required for efficient learning they typically fail lose self-confidence in their ability to learn, become thoroughly demoralized in the school situation and disinvolve themselves from it Much of the lower-class child s alienation from the school, therefore, is not so much a reflection of discriminatory or rejecting attitudes on the part of teachers and other school personnel—although the importance of this factor should not be underestimated, it is in greater measure a reflection of the cumulative effects of a curriculum that is too demanding of him and of the resulting load of frustration, confusion demoralization resentment, and impaired self-confidence that he must bear

In this section we shall consider only the cognitive aspects of an appropriate teaching strategy for culturally deprived children The basic principles underlying this strategy are essentially little different than those applying to the instruction of *any* pupil As J S Bruner (1960) points out, however, it is the less able student who suffers most from poor teaching In another chapter we shall discuss motivational, social, and interpersonal considerations applicable to the culturally disadvantaged

An optimal cognitive environment for culturally deprived pupils focuses on the two complementary aspects of cognitive readiness for learning—readiness in terms of general level of intellectual functioning and readiness in terms of specific subject matter background It emphasizes, therefore, these four considerations (a) *prevention* during the preschool years of the intellectual and language retardation characteristic of children growing up under culturally disadvantaged circumstances, (b) the selection of learning tasks at all stages of the curriculum that are consonant with the learner s *existing* state of readiness (c) mastery and consolidation of all ongoing learning tasks before new tasks are introduced, so as to provide the necessary foundation for successful sequential learning and to prevent unreadiness for future learning tasks and (d) the use of structured and self paceable learning materials optimally organized to facilitate efficient sequential learning Attention to these four factors can go a long way toward insuring effective learning for the first time, and toward restoring the culturally deprived child s educational morale and confidence in his ability to learn Later possible consequences are partial restoration of both in trinsic and extrinsic motivation for academic achievement diminution of anti intellectualism and decreased alienation from the school to the point where his studies make sense and he sees some purpose in learning

### *Preschool Enrichment*

Much of the discouraging picture of language retardation in the culturally deprived child and of its grim consequences for school learning could undoubtedly be prevented by an enriched program of preschool educa tion that would emphasize perceptual discrimination and language acquisi tion In addition to the usual preschool activities much time would be spent in reading and talking to children in furnishing an acceptable model of speech in supplying corrective feedback with respect to grammar and pronunciation in developing listening memory and attentivity skills and in providing appropriate reading readiness reading and writing instruction Concomitantly of course an attempt would be made to raise the cultural and intellectual level of the home through a long range program of involve ment in adult education Although formal instruction in reading is probably inadvisable for preschool children generally and presents many definite hazards (Kinsella 1965) it does have a defensible educational rationale as a *preventive* measure among the culturally deprived (despite the difficulties and hazards involved) in view of the widespread occurrence of reading retardation in this group At the kindergarten level the hazards of formal reading instruction are less formidable and its benefits are more firmly established especially among bilingual children (S E Herr 1946)

### *Readiness*

General unreadiness for school learning among culturally disad vantaged children largely reflects their slower and less complete transition from concrete to abstract modes of thought during the junior and senior high school years Thus in the presentation of abstract ideas and proposi tions it is important for instructional materials and audiovisual aids to provide more concrete empirical props and opportunities for direct physical manipulation of objects and situations than would be considered desirable in a more typical classroom[3] Such props for example might include gener ous use of such techniques as Cuisenaire rods the abacus schematic models

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[3] In addition to promoting the understanding of abstractions such overt manipulative activity is also consistent with the deprived child s more physical or motoric mode of learning (Riessman 1962) The same consolidation would apply to overt versus passive responding in programmed learning and to discussion versus lecture modes of presentation

and diagrams, and role playing activities In the teaching of mathematics and science, much reliance would be placed on the applicability of principles to common problems in the immediate environment and on supportive illustrations and analogies drawn from everyday experience It should be appreciated however, that these techniques are merely ways of facilitating the transition to a more abstract level of cognitive functioning We do not want to induce permanent dependence on concrete-empirical props or to be satisfied with this state of affairs as our ultimate objective

Specific subject matter unreadiness among culturally deprived children is a consequence of their failure to master the basic intellectual skills and to acquire an adequate foundation of integrative concepts and principles in the hierarchically organized disciplines It is essential, therefore, that the initial selection of learning materials take account of pupils existing state of knowledge and sophistication in the various subject matter areas, irrespective of how primitive this happens to be Once the appropriate starting point is ascertained continued subject matter readiness can then be assured by using structured sequentially organized materials and by insisting on mastery of all ongoing lessons before new learning tasks are introduced These latter teaching strategies can, in turn be most effectively implemented through the kind of programmed instruction described above

A curriculum that takes the readiness of the culturally deprived child into account always takes as its starting point his existing knowledge and sophistication in the various subject matter areas and intellectual skills, no matter how far down the scale this happens to be This policy demands uncompromising elimination of all subject matter that he cannot economically assimilate on the basis of his current level of cognitive sophistication It presupposes emphasis on his acquisition of the basic intellectual skills before any attempt is made to teach him algebra literature, science, and foreign languages However, in many urban high schools and junior high schools today, pupils who cannot read at a third grade level and who cannot speak or write grammatically or perform simple arithmetical computations as subjected to irregular French verbs, Shakespearean drama, and geometrical theorems Nothing more educationally futile or better calculated to destroy educational morale could be imagined!

In terms of readiness for a given level of school work, a child is no less ready because of a history of cultural deprivation, chronic academic failure, and exposure to an unsuitable curriculum than because of deficient intellectual endowment Hence, realistic recognition of this fact is not undemocratic, reactionary, or evidence of social class bias, of intellectual snobbery, of a 'soft,' patronizing approach, or of a belief in the inherent uneducability of lower-class children Neither is it indicative of a desire to surrender to the culturally deprived child s current intellectual level, to perpetuate the status quo, or to institute a double class-oriented standard of education It is merely a necessary first step in preparing him to cope with more advanced subject matter, and hence in eventually reducing existing social class differentials in academic achievement To set the same initial standards and expectations for the academically retarded culturally deprived child as for the non retarded middle or lower class child is automatically to insure the former's failure and to widen prevailing discrepancies between social class groups

With respect to the culturally disadvantaged child's language retardation, a sorely needed change within the classroom setting is the long overdue introduction of more imaginative and effective ways of teaching the language arts More emphasis, for example, needs to be placed on the mastery of the principal syntactical forms in spoken and written discourse, through repetitive practice with feedback, than on the pedantic and essentially trivial labeling and classifying of different varieties of grammatical structure The culturally deprived child with his pragmatic and nonabstract approach to knowledge couldn't care less after all, about the different parts of speech and the various esoteric names attached to the different uses of each, and, for the most part, he is correct insofar as the value or functional utility of much of such knowledge is concerned

It seems clear, therefore, that both in preschool and school programs for the culturally deprived, exclusive emphasis on either verbal or concrete empirical aspects of instruction represents a pseudo dichotomy Culturally deprived pupils must obviously be helped to overcome their language retardation If they are ever to function competently as abstract, verbal learners, they must acquire a basic repertoire of verbal concepts and tranactional terms as well as a basic mastery of syntax But the very fact of their language retardation also requires simultaneous compensatory remediation along concrete empirical lines In the preschool and kindergarten (preoperational) period, like all children at this stage of development they are highly dependent on concrete empirical experience and on the manipulation of objects or images in relational learning concept formation and problem solving they are unable to relate abstract relationships to cognitive structure in correlative, superordinate or combinatorial fashion And since they must also achieve a certain critical level of proficiency at the stage of concrete logical operations before they can move on to the stage of abstract logical operations and since existing language retardation delays this transition, they are dependent longer than are their nondeprived peers on concrete empirical props in various forms of relational learning before attaining the abstract stage of cognitive development

### *Teaching and Administrative Arrangements*

The success of this type of teaching strategy naturally depends a great deal on the availability of dedicated teachers who have been specially trained and are desirous of working with culturally deprived children They must *really* be concerned that materials are genuinely understood and mastered, and must be able to convey the impression that they are confident of and expect successful learning from their pupils This obviously assumes much more personal involvement in the teaching function and in the intellectual development of culturally deprived children than merely going through the motions of presenting subject matter while being essentially indifferent about learning outcomes[4] For purposes of restoring intrinsic motivation for learning (cognitive drive), it is also important that teachers be able to communicate a sense of excitement about the subjects they teach, and that they be the kinds of mature, stable, and self-confident persons with whom children can identify This latter objective can also be furthered by the assignment of more male teachers to schools in culturally deprived neighborhoods, by lowering the pupil teacher ratio, by using multiple period classes, and by keeping teachers with the same elementary school classes over a period of several years Ungraded and ungrouped elementary school classes facilitate the process of enabling each child to progress at his own pace without being subjected to the discouraging and stigmatizing effects of nonpromotion and placement in slow learning groups

Other types of compensatory educational arrangements that have been suggested for the culturally deprived child include particularly intensive remedial work in reading, academic coaching, an extended school day and school week, free summer school, the postponement of formal instruction in the first grade for pupils who have not had preschool and kindergarten training and a 5 year high school and college program for the academically slow-developing individual For high school students whose school orientation is definitely vocational realistic prevocational courses should be provided in the eleventh and twelfth grades, integrated in some instances with work experience and apprenticeship programs

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[4] This does not necessarily imply a permissive or child-oriented' as opposed to a task-oriented approach to teaching The family background of culturally deprived and of lower social class children generally does not make them very responsive to a permissive environment characterized by either laissez faire attitudes or unstructured techniques of instruction (Riessman 1962)

Chapter 8

# PRACTICE

MEANINGFUL LEARNING REFERS TO THE ACQUISITION of meanings, and to the nontransitory organizational changes in cognitive structure accompanying this process as the learner responds to initial and successive presentations of the learning task Although much significant meaningful learning obviously occurs during initial presentation of the instructional material, both overlearning as well as most long term retention, in class rooms and similar settings presuppose multiple presentations or trials (practice), and both learning process and outcome customarily encompass various qualitative and quantitative changes that take place during these several trials Learning and retention, therefore, ordinarily imply practice Such practice, furthermore, is typically specific (restricted to the learning task) and deliberate (intentional) Long term organizational changes in cognitive structure that occur in the demonstrable absence of specific and deliberate practice experience (that is incidental learning) may be more properly considered manifestations of maturation Short term fluctuations in the availability of learned material, on the other hand, are reflective of changes in the threshold of availability

As previously suggested, the effects of practice both reflect the influence of existing cognitive structure and also modify that structure Thus, the cognitive impact of initial presentation of potentially meaningful new learning material (the emergence of new meanings) is largely determined by the organizational attributes of the established ideas in cognitive structure to which the learning task is related, and by establishing these new meanings in cognitive structure such presentation influences, in turn, both the learner s response to subsequent trials of the same learning task and his learning of related new materials Practice, therefore, affects learning and retention by modifying cognitive structure Generally speaking, it increases the sta bility and clarity of newly learned meanings in cognitive structure and hence enhances their dissociability strength and retention

Practice in other words is not a cognitive structure variable itself but is one of the principle factors (along with instructional materials variables) influencing cognitive structure The most immediate effect of practice is to increase the stability and clarity and hence the dissociability strength of the emergent new meanings in cognitive structure In turn the increments and decrements in the stability and clarity of the new meanings (and the correlated changes in their dissociability strength) accompanying their initial learning inter trial forgetting and later learning facilitate the learner s assimilation of the instructional material during subsequent trials As will be postulated later the changes in cognitive structure wrought by the first trial (namely the establishment of the new meanings) sensitize the learner to the potential meanings inherent in the material and the forgetting that occurs between successive trials or reviews immunizes him (enables him to take preventive steps) against further forgetting following additional trials In addition the consolidation of this new material as a result of practice makes available in cognitive structure stable new anchoring ideas for other related learning tasks introduced at a later date Practice therefore influences cognitive structure in at least four different ways it increases the dissociability strength of the newly learned meanings for a given trial and thereby facilitates their retention it enhances the learner s responsiveness to subsequent presentations of the same material it enables the learner to profit from inter trial forgetting and it facilitates the learning and retention of related new learning tasks

But even if each learning trial influences subsequent learning trials by virtue of its sensitizing and immunizing effects on cognitive structure the mediating influence of these effects on the next practice trial are not experimentally measurable The transfer paradigm (comparing learning outcomes of the two groups after the experimental group receives two trials and the control group receives only one trial) is inapplicable under these circumstances As long as training and criterion tasks are identical (consist of two presentations of the *same* material) it is impossible in accounting for the superiority of the experimental group on the second learning trial to distinguish between (a) the practice effect *itself* (the direct effect of an additional presentation upon learning or dissociability strength) and (b) the *indirect* mediating (sensitizing or immunizing) influence of previously altered cognitive structure In classical transfer situations on the other hand inasmuch as criterion and training tasks differ the superiority of the experimental group on the criterion task can be unequivocally attributed to the modification of cognitive structure induced by the training task It goes without saying however that simply because the influence of a cognitive structure variable is not demonstrable under certain conditions we cannot warrantedly infer that it does not affect learning retention outcomes The reality of a variable's effect on a phenomenon cannot be denied just because the variable itself currently defies reliable and valid measurement, or because experimental or statistical procedures are not yet available to isolate this effect from that of other variables

In this chapter we shall *not* be concerned with the problem of how different dimensions of the practice variable (overlearning multi contextual exposure) affect transfer, that is influence the meaningful learning and retention of *new* material by altering cognitive structure We will consider instead the effects of repeated presentations of the *same* learning task (practice) on the learning and retention of that task Relevant dimensions of the practice variable to be considered include the number, type and distribution of practice trials the method and general conditions of practice, and the learner's awareness of the effect of practice on learning retention outcomes (feedback) It should be appreciated however, that only a slight alteration in experimental design would be necessary to make the relevant studies in this area conform to the transfer paradigm and thus shed light on the pedagogically more significant issue of how different aspects of practice influence the meaningful learning and retention of related new material

Unfortunately, most of our knowledge about the effects of practice variables pertains to rote and motor learning and to single rather than sequentially organized tasks The research void with respect to the role of repetition in meaningful verbal learning is especially glaring despite the time honored place of practice and review in pedagogic technique Practically all of the research conducted to date has dealt either with the frankly rote type learning of nonsense syllables and paired adjectives or with the verbatim learning of such potentially meaningful material as poetry and short prose passages

## Frequency[1]

In terms of historical significance theoretical importance, and relevance for current educational practice, few issues in educational psychology are more crucial than the role of frequency in learning and retention Yet ever since E L Thorndike (1931, 1932) repudiated the law of frequency, the theoretical stance of educational psychology on this issue has tended to be confused contradictory and somewhat schizophrenic On the one hand in accordance with Thorndike's pronouncement it is held that frequency in itself is unnecessary for and really makes little difference in learning outcomes and this position finds much favor with progressivist educators who

[1] Some of the material in this section has been excerpted from an article Is Drill Necessary? The Mythology of Incidental Learning by the author in the *Bulletin of the National Association of Secondary School Principals*, 1963 *47*, 44 50 Reprinted by permission of the National Association of Secondary School Principals 1963 Copyright Washington D C

are hostile to drill of any kind with Gestalt theorists who conceive of all learning as insightful and with discontinuity ( nonincremental ) learning theorists who maintain that learning invariably takes place in a single trial Thus we frequently tend to minimize the role of drill in educational theory regarding it as rote mechanical passive and old fashioned as psycholog ically unnecessary for the learning process and as actually harmful for ac tive meaningful learning

The progressivists of course did not entirely deny the value of prac tice As a matter of fact both their espousal of naturalism incidental learning and of project and activity programs as well as their battle cry of learning by doing carried an implied endorsement of the importance of appropriate practice But by appropriate practice they meant direct (con crete manipulative) nondeliberate (unintentional) and autonomous (un guided) learning encounters with different (diversified) examples of the same concept or principle in uncontrived real life situations Their mistake lay in assuming that all structured practice (drill) is necessarily rote that un structured unguided and unintentional (incidental) practice is maximally effective for school learning tasks and that doing necessarily leads to learning simply because it involves direct experience and occurs repeatedly in natural problem solving situations

Actually for practice to result in meaningful mastery of material the only really essential conditions are that the learning task be potentially meaningful that the learner exhibit a meaningful learning set and possess the necessary anchoring ideas and that the number distribution sequence and organization of practice trials conform to empirically established prin ciples of efficient learning and retention Not only is the uncontrived or unstructured quality of practice an unessential condition of meaningful effective learning but it also often leads to no meaningful mastery what soever This is so because incidental practice is typically haphazard in terms of frequency and distribution of trials and because the spontaneous un structured organization of learning experiences is more frequently than not inconsistent with established criteria of effective programming Problem solving and laboratory exercises may similarly lead to little or no meaning ful learning if the student s learning set is simply rotely to memorize type problems or techniques of manipulating symbols and if he has inadequate background in or appreciation of the methodological principles illustrated by specific laboratory procedures It should also be realized finally that just as doing does not necessarily lead to understanding understanding does not necessarily imply ability successfully to solve problems involving mean ingful appreciation of the principles in question Factors other than under standing are also implicated in the outcome of problem solving activities

On the other hand educational psychologists implicitly accept the con cept of a learning curve in which gradual increments in learning are plotted against successive trials and they place great stress on the impor tance of overlearning for long term retention and transfer This latter position is actually adopted by the vast majority of teachers, coaches, parents, and students who follow the maxim that 'practice makes perfect" Quite obviously, both positions cannot be simultaneously valid The upshot of this conflict in our beliefs is that we still place considerable reliance on drill in actual classroom teaching, but do so half heartedly, apologetically, and in ways that detract from its effectiveness Actually, on theoretical grounds, there are many reasons for believing that repetition is typically required not only for the retention of adequately clear, stable, and valid meanings (and often for their acquisition as well), but also for that degree of consolidation of antecedent portions of sequentially organized subject matter that is necessary for efficient learning of subsequent portions

### *Meaningful versus Rote Learning and Retention*

The role and significance of frequency are different for meaningful than for rote learning and retention precisely because rote and meaningful learning processes themselves are so different from one another Repeated encounters with the same array of stimulation presumably enhance rote learning and retention by increasing the strength of discrete, arbitrary, and verbatim associative linkages, that is, their resistance to the short term interfering effects of prior and subsequent stimulation The same repetitiveness presumably enhances meaningful learning and retention by increasing the dissociability strength of instructional materials that have been nonarbitrarily and substantively incorporated in relation to an existing concept or principle in cognitive structure, that is it enhances the emergence of clear and stable meanings and their resistance to forgetting (Ausubel, 1962c)

Thus it is reasonable to assume that sheer repetition would play a more significant role in the learning and short term retention of discrete and arbitrary associations, largely isolated from cognitive structure, than it would in the learning and longer term retention of materials that can be meaningfully incorporated within that structure In meaningful, as opposed to rote, learning situations, such other factors as the availability of clear and stable anchoring ideas, the discriminability between these anchoring ideas and the learning task, and the internal logic and lucidity (the logical meaningfulness) of the learning task undoubtedly detract somewhat from the role played by repetition Nevertheless the influence of repetition is still considerable in the establishment and consolidation of meanings and in the enhancement of their resistance to decremental processes In any case, it cannot be dismissed as basically extrinsic to the process whereby increments in availability are effected

From the standpoint of frequency, the chief practical implication of the differences between rote and meaningful learning for classroom teaching is that review can, and largely should, take the place of practice Since mean ingful learning occurs relatively quickly, and since the forgetting of meaningfully learned materials takes place relatively slowly, much of the potentially facilitating effects of frequency can be used more profitably for review than for original learning purposes. In terms of what is actually learned and retained, in other words, the relatively long interval between the initial learning and the review sessions in the case of meaningful learning is comparable to the short inter-trial practice interval in the case of advanced stages of rote learning. Thus, in teaching the meanings of a series of programmed scientific terms, J. H. Reynolds and R. Glaser (1964) recently found that "repetition has only a transitory effect upon retention," whereas "spaced reviews produce significant facilitation in retention of the reviewed material."

## *Frequency and Learning*

Until relatively recently, most of the empirical research bearing on the frequency issue in rote learning had been conducted by E. L. Thorndike (1931, 1932). In amassing experimental evidence against the role of frequency, however, he chose highly atypical learning tasks that could not possibly be mastered in the absence of either explicit intention or knowledge of results, respectively, and then deliberately failed to provide these conditions. Hence, since the minimally necessary conditions for learning were lacking in his particular experiments, he did not find it very difficult to demonstrate that numerous repetitions of the task, under the same impossible conditions he set, were just as ineffective for learning as was the provision of a single trial. Needless to say, despite the fact that such evidence is almost universally cited in educational psychology textbooks as definitively proving the negligible influence of frequency by itself on learning, it merely demonstrates that certain atypical kinds of learning cannot take place in the absence of explicit intention or feedback, no matter how frequently the learning task is repeated.

In one series of experiments, for example, Thorndike endeavored to prove that frequency has no effect in the absence of belongingness, and by eliminating this latter condition successfully demonstrated that frequency was in fact ineffective. This result was hardly surprising because, although contiguity is an essential condition of associative learning, not all contiguous events are necessarily associated; some selectivity based on belongingness is always involved in the particular items that are associated. In the case of meaningful learning material, belongingness is a reflection of functional or logical relatedness. In rote learning tasks, however, where the association to be formed is purely arbitrary, belongingness is established either by explicit instructions (and the formation of corresponding explicit sets or intentions) or by habitual expectancies based on previous experience. Hence much incidental learning' (learning in the absence of explicit instruction and intention) can occur either if the learning material is meaningful, or if *the rote learning task is constituted in accordance with habitual expectancies*[2] But if a particular rote learning task is unrelated to or inconsistent with habitual expectancies (for instance associating the second member of one paired associate with the first member of the next paired associate in the series), it is understandable that little or no learning will occur in the absence of explicit intention, despite numerous contiguous repetitions (E L Thorndike, 1931, 1932)

From the latter experiments, therefore, one could warrantedly infer that, in addition to contiguity, belongingness is essential for associative learning, and that belongingness can either be established implicitly (in potentially meaningful material or in familiar rote tasks) or by explicit intention (in unfamiliar rote tasks) One could *not* justifiably conclude either that explicit intention is necessary for *all* learning, or that frequency by itself has no effect whatsoever on learning True, in the absence of belongingness frequency is ineffective because no learning at all can occur This does not mean however, that when belongingness *is* present, the improvement that occurs with repetition must necessarily be attributed to belongingness rather than to frequency

Similarly, in another widely cited series of experiments, E L Thorndike (1931, 1932) showed that in the absence of knowledge of results, frequency of repeating certain tasks (for instance, drawing a line of specified length, estimating the length of paper strips) bears no relation to learning (improvement) In instances where a constant stimulus situation is repeated but the response is variable or indeterminate, it is obvious that some knowledge of results is essential for learning Feedback, however, is not indispensable for learning in situations either where *both* stimulus and response are specified or where the learner s task is simply to reproduce the material that is presented to him Furthermore, not only is frequency effective in these latter instances where feedback is *not* required for learning but it also enhances learning in those situations where feedback *is* essential and is provided

In many military and industrial training situations involving perceptual motor skills (for instance gunnery) and the learning of sequential procedures practice of the task itself apparently has no facilitating effect

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[2] Children for example acquire much specific information about objects irrelevant to the solution of particular incentive motivated problems (Stevenson 1954) and without any obvious motivation for so doing they effectively retain over long periods of time information presented in motion pictures (Holaday and Stoddard 1933) Experimenters who administer lists of nonsense syllables to subjects incidentally learn many of these syllables themselves (Jenkins 1933)

and was followed by the retention test after an equal time interval for both groups The same relearning of the material constituted early or delayed review for the two groups as a result of varying the interval between original learning and review Even under these experimental conditions the earlier findings were confirmed

The results of this latter experiment can be best explained by supposing that the respective advantages of early and delayed review counterbalance each other The theoretical advantages of delayed review are perhaps more self evident than those of early review In the first place after a longer retention interval when more material is forgotten the learner is more highly motivated to profit from the opportunity for review He is less likely to regard this opportunity as unnecessary and superfluous and is therefore more disposed to take good advantage of it in terms of effort and attention Second and even more important *prior forgetting* conceivably has a facilitating ( immunizing ) effect on meaningful learning and retention because as a result of both trying and failing to remember material the learner tends to become aware of negative factors in the learning and retention situations that promote forgetting that is of areas of instability ambiguity confusion and lack of discriminability (Ausubel and Youssef 1965) Thus forearmed he can take the necessary steps during the relearning session to strengthen particularly weak components of the learning task to resolve existing confusion and ambiguity and to increase discriminability between previously learned ideas and related new propositions Furthermore it would seem that greater potential benefit could presumably be anticipated from repetition when a larger proportion of the learning task is forgotten inasmuch as more remains to be relearned under these circumstances

In what ways can early review conceivably counterbalance these evident advantages of delayed review? The most likely possibility is that repetition (review) has a specially potent consolidating effect on recently learned material while it is still appreciably above the threshold of availability and that this consolidating effect decreases as the material becomes progressively less available Obviously another trial provides additional opportunity for the learner to interact cognitively with the learning material and to relate the potential meanings it embodies to his existing structure of knowledge thereby enabling actual or experienced meanings to eventuate and/or be consolidated He has in other words another opportunity to acquire meanings potential in the material that he partially or completely missed on the first trial as well as to consolidate meanings initially established at that time To be optimally effective however the opportunity for such consolidation may very well presuppose a certain minimal level of residual availability

Another study trial also provides the learner with informational feed back in the form of textual reference for testing the correctness of the knowledge he retained from the first trial This testing confirms correct meanings clarifies ambiguities corrects misconceptions and indicates areas of weakness requiring differential concentrated study The net effect is consolidation of learning When the *learning task is largely forgotten however* as in delayed review the feedback role of repetition is minimal

In what other ways may early review be more advantageous than delayed review It will be remembered that in addition to enhancing meaningful learning and retention in the two aforementioned direct ways repetition also influences these processes in another indirect way through modification in cognitive structure wrought by earlier trials Not only do repeated presentations of the learning task strengthen the newly acquired cognitive content but the latter cognitive content itself also *reciprocally* induces changes in the *perceived* learning task which make it more learnable That is initial acquisition of the meanings of the learning material and their presence in cognitive structure *sensitize* the learner to the potential meanings it contains when he encounters it again Since he had previously derived meanings from the learning material on the first trial—by incorporating potential meanings into his cognitive structure—now the new ideas as a whole not merely the component words immediately (that is perceptually) convey *actual* rather than merely *potential* meaning to him on second reading

Hence on the second trial actual rather than potential meanings interact with the residue of those recently acquired meanings in his cognitive structure which were established as a consequence of his first encounter with the material This type of interaction particularly enhances consolidation of the previously established meanings because this time the learner does not have to *grasp* meanings and can concentrate solely on trying to *remember* them Moreover establishment of gross meanings on the first trial sensitizes the learner to more refined meanings and subtle distinctions on the second trial It stands to reason therefore that both the consolidation and sensitizing effects of repetition are greater earlier rather than later during the retention interval when more of the learned meanings are still available to exert sensitizing effects or to be consolidated

In summary then the principal advantage of early review would appear to be its superior consolidating feedback and sensitizing effects in relation to more highly available material whereas the principal advantage of delayed review probably inheres in the superior relearning of forgotten material both on motivational and cognitive grounds Thus since each kind of review has its own distinctive function and advantage the two varieties are presumably complementary rather than redundant or mutually exclusive and can thus be profitably combined

## *How the Influence of Frequency is Mediated*

The role and importance of frequency (number of trials or presentations) in learning and retention have received varying emphasis over the years in psychology and education For the most part in the history of psychological thought frequency has been regarded as one of the cardinal laws of associative learning and more recently of classical conditioning as well In the early thirties however the law of frequency received a severe setback at the hands of E L Thorndike who concluded after much experimentation that frequency *in itself* has little or no impact on the learning process and that its supposed influence must really be attributed to reinforcement (satisfying effect) knowledge of results belongingness or intention (1931 1932)

The authority of Thorndike s pronouncement was subsequently bolstered by the influence of such nonfrequency conceptions of learning as the Guthrian contiguity single trial model of learning (Estes 1960 Estes Hopkins and Crother 1960 Guthrie 1952 Rock 1957) the Hullian emphasis on drive reduction as the principal variable determining habit strength (Hull 1943) the Skinnerian preoccupation with reinforcement in operant conditioning (Skinner 1938) E C Tolman s view of learning as the gradual acquisition of cognitive sophistication (1932) and the Gestalt formulation of learning as the abrupt emergence of insight (Kohler 1925) The combined influence of these theoretical developments in the psychology of learning and of the prevailing progressivist and child-centered trends in the philosophy of education led to a widespread de-emphasis of the value of practice or drill in the teaching learning process Drill was unwarrantedly stigmatized as necessarily rote in nature and a fetish was made of uncontrived unstructured and incidental learning experience

It is apparent therefore that two principal issues must be considered in evaluating the role of frequency in learning and retention First is repetition typically required both in gradually establishing associative or dissociability strength at or above threshold level (learning) and in sufficiently enhancing such strength so that the span of retention is extended or is all effective learning and retention actually accomplished in a single trial? Is frequency in other words *organically* related to the learning retention process or is gradual improvement with repetition merely an artifactual consequence of various circumstances involved in the investigation measurement and representation of learning retention outcomes? Second does frequency affect learning and retention in any distinctive way apart from affording repeated opportunities for other variables such as contiguity drive reduction and confirmation-clarification to operate in cumulative fashion?

Our position regarding both the role and mediation of frequency in meaningful verbal learning and retention has already been made clear in discussing the effect of temporal position on review Evidently, frequency is neither a necessary nor a sufficient condition for meaningful learning to occur The substance of much relatively easy, potentially meaningful material can be grasped after one reading Typically, however, several rereadings are required for more difficult learning, for overlearning, for delayed retention, and for transfer Frequency, in other words, usually makes a difference in meaningful learning and retention On the other hand, in the absence of a meaningful learning set, of potentially meaningful material, of sufficient effort and attention, of active attempts to understand, of intention to integrate knowledge and to reformulate it in idiosyncratic terms, and of belongingness, feedback, and intention (where these are necessary for learning), no amount of frequency *by itself* can eventuate in substantial amounts of meaningful learning In addition, we have insisted that practice *alone* does more than just provide opportunity for such variables as contiguity, reinforcement, feedback, belongingness and intention to influence learning Subsequent opportunities to encounter learning material are facilitated by the cognitive changes (emergence of meaning, forgetting) already wrought by the initial encounter, as well as by the cognitive changes (increased dissociability strength) that they themselves induce

Thus we hold that frequency has a distinctive effect of its own on learning and retention that operates in addition and cannot simply be reduced, to the opportunity which subsequent trials provide for other effective variables *to influence, in cumulative fashion, the process and outcome of learning* and retention That is, we propose that frequency does more than merely make possible a summation of the repeated effects of some other variables such as contiguity, reinforcement through drive reduction, or cognitive confirmation and clarification Frequency does admittedly provide opportunity for the recurrent operation of these variables, but it also serves as more than just a vehicle for the cumulation of their repeated effects [5]

Frequency is obviously insufficient for learning under conditions that

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[5] Some of the effect of repetition on learning and retention probably has a neurophysiological basis related to the theory that repeated excitation of a given neural connection lowers the synaptic resistances involved This theory is in accord with the well established facts that (a) everything else being equal the older of two memory traces is stronger and is strengthened more by practice (Jost s laws) and (b) memories in storage tend to increase in strength over time It is also consistent with the pattern of memory loss and recovery in amnesia cranial trauma electroshock therapy and senile dementia—with the fact that older memories are lost last and recovered first (Wooldridge 1963) Not only does repeated re excitation apparently lower synaptic resistances but so also do randomly and spontaneously generated electric brain currents The latter phenomenon would account, in part both for Jost s laws and for the superiority of distributed practice

lead either to extinction (lack of reinforcement) or to motivation *not* to learn (for instance punishment) The same holds true for conditions that either presuppose prior knowledge which is absent in a particular learner or call for discovery or difficult reception learning that may or may not take place Some learners for example may never acquire the necessary insight for certain kinds of insightful problem solving In other instances frequency may gradually engender the necessary understanding or insight Although this insight may appear to arise very abruptly it may actually reflect the testing of many prior hypotheses and their reformulation following negative results

INCREMENTAL VERSUS NONINCREMENTAL THEORIES It appears that evidence in support of the incremental (continuity) conception of learning and of the importance of frequency can be derived from the overwhelming majority of research studies in the field irrespective of the type of learning involved In addition to these studies of practice evidence has already been presented which suggests that prior *over*learning of relevant material during a training period facilitates the learning of related new material (induces positive transfer) by enhancing the stability and clarity of the training concepts in cognitive structure

But theorists who deny that frequency intrinsically influences learning retention outcomes do not seem at all impressed by the apparently irrefutable evidence implicit in the very shape of the learning curve They attribute the gradual improvement that occurs with repetition to various methodological artifacts Gestalt and field theorists (Koffka 1935 Kohler 1925 Krechevsky 1932 1938 Lashley 1929) for example typically assert that learning (insight) occurs suddenly and that the trials preceding the attainment of insight have no real effect on its emergence Learning they contend, only *appears* to be incremental either because the grossness of existing measuring instruments obscures the abrupt acquisition of partial insights or because the pooling of data from many subjects who achieve insight on an all-or none basis during different trials results in a smooth and gradual group learning curve E R. Guthrie (1952) also espouses an all-or none concept of learning for any particular stimulus-response connection attributing the apparent improvement with practice to unavoidable variability in the stimulus situation over a series of trials which in turn leads to ever increasing stimulus generalization and correspondingly greater probability of response elicitation Lastly according to I Rock frequency appears to be necessary in learning a list of paired associates because only a limited number of associations can be formed on any one trial (Rock 1957 p 186)

Some evidence against the role of frequency in rote learning has been adduced from various experiments on single trial paired associate learning (Estes 1960 Estes Hopkins and Crother 1960 Rock 1957) Rock modified the conventional paired associate technique of presentation so that his experimental subjects would have only a single trial in which to learn any given pair This was accomplished by removing from the list (on the subsequent trial) all pairs that were not learned on the previous trial and substituting new pairs He found that subjects who learned lists of paired associates presented in this manner learned them just as rapidly to a criterion of one errorless trial as did control subjects who by following the conventional procedure had one or more additional trials in which to learn those pairs missed on the first trial W K Estes B L Hopkins and E J Crother (1960) have also shown that when a list of paired associates are studied only once items which are incorrect on the first trial almost invariably tend to be incorrect on the second test trial Since the probability of making a correct response under these circumstances apparently does not increase from the first test trial to the second they concluded that associative strength either increases from 0 to 100 per cent on a given trial or shows no increase whatsoever

These latter studies however neither provide more definitive evidence than Thorndike s aforementioned research in ruling out the effect of frequency on learning nor demolish the incremental conception of learning In addition to such methodological difficulties in both studies as failure to control for item difficulty[6] (Lockhead 1961 Postman 1962 Underwood and Keppel 1962 Underwood Rehula and Keppel 1962 Wollen 1962) Estes interpretation of his findings does not allow for the possibility that frequency may result in gradual *subliminal* increments in associative strength that is in increments below threshold value that are not reflected in performance If for example a single study trial increases the associative strength of a given item in a list of paired associates but does not do so to threshold level the subthreshold strength of the item is no more likely to lead to a correct response on a second test trial than on the first test trial provided that no study has intervened between the two test trials Hence the fact that the particular items incorrect on the first test trial also tend to be incorrect on the second test trial does not warrant the conclusion that the first study trial induces no learning whatsoever in the apparently unlearned (subthreshold) items or no learning that could be incrementally benefited by a second trial

The notion of incremental learning in which frequency plays a significant role is of course by no means incompatible with the possibility that later trials may have a differentially greater effect on the yet unlearned com

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[6] It seems highly probable that the particular items in a series of paired associates which a given subject fails to learn are more difficult for him than those items which he succeeds in learning even if the two sets of items can be considered equally difficult when some *average* criterion of difficulty such as Glaze value is applied

ponents of a total learning task than on those items already above threshold level Deductively it would also appear that this differential effect of later trials is less significant when trials are distributed rather than massed inasmuch as a long interval between trials leads to some forgetting of the learned items and hence to less difference in associative strength between learned and unlearned items In more complex kinds of mathematical learning P Suppes and R Ginsberg (1962a) concede that the all-or none model can not explain all of the evidence

One trial learning theorists are divided on the relationship between frequency and *retention* Estes Hopkins and Crother (1960) claim that their experimental evidence refutes the traditional finding that overlearning enhances retention but I Rock while insisting that repetition plays no role in the formation of associations other than that of providing the occasion of new ones to be formed each in a single trial concedes that repetition *after* the association is formed is effective in strengthening it (Rock 1957 p 193)

Advocates of the incremental position of course insist that typically with each successive trial associative strength is gradually increased until it reaches or exceeds threshold level rather than that the entire gain in associative strength is necessarily acquired in the single trial preceding the appearance of the correct response They implicitly assume in other words that the increment in associative strength is attributable in whole or in part to the effect of repeated presentations of the learning task that is to the influence of frequency alone and B J Underwood has more explicitly defended the role of frequency as such in rote verbal learning insisting that at the very least it is related to familiarity and thus accounts in part for the availability of response if not for the associative strength aspect of paired associate learning (Underwood 1959)

It is quite apparent that the issue regarding the role and importance of frequency in learning and retention is far from being settled Nevertheless the weight of the evidence and logic suggests that learning is typically a gradual (continuous) rather than an all-or none (discontinuous) phenomenon that it reflects a summation of increments in associative or dissociability strength wrought by repeated presentations of the learning task and that the apparent abruptness of some learning outcomes ( insight ) really masks the occurrence of much prior hypothesis-formulation testing rejection and -confirmation activity which is organically related to the supposedly sudden emergence of the correct insight Even conceding that learning may sometimes occur in a single trial and that frequency seldom operates alone in learning and retention but rather in conjunction with other variables (for example the stability and clarity of related concepts in cognitive structure intention to learn reinforcement knowledge of results or feedback internal organization of the learning task) we can tenta tively conclude that the frequency factor both actively interacts with these other variables as well as constitutes a significant variable in its own right in influencing learning retention outcomes Evidence indicating that in certain kinds of learning tasks frequency has no effect in the absence of belongingness explicit intention reward or feedback does not warrant the conclusion that when these factors are present most of the improvement accompanying repetition must be attributed to them rather than to frequency alone as a matter of fact there is much suggestive evidence that frequency can often enhance learning in the absence of explicit intention knowledge of results or drive reduction

It is not asserted of course that increments in learning necessarily occur at a uniform rate over a series of trials or that those components of a task that are already learned are benefited as much by later trials as are the yet unlearned components But even after a given association is established or a given meaning or means end relationship is correctly apprehended additional repetition increases associative or dissociability strength still further thereby enhancing retention

### *Transfer versus Direct Practice in Sequential Learning*

Repetition is important not only for the mastery of the current or ongoing learning task but also for the learning of new sequentially dependent tasks that presuppose such mastery or consolidation of the current task This of course is an example of positive transfer The relative value of transfer and direct practice has already been considered in another context In a sequentially dependent learning situation one would expect degree of retained knowledge of early background material crucially to affect learning of the later material by providing relevant ideational scaffolding for it Hence if such relevant ideational scaffolding were available and were clear and stable it should provide a better foundation for new learning and retention than if it were not available or if available were not clear and stable The stability and clarity of antecedent cognitive structure also affect the discriminability of new learning material from previously learned knowledge Repetition of the early background material therefore is one of the factors that enhances its stability and clarity and hence should facilitate the learning of sequentially dependent later material

The facilitating effect of repetition (consolidation) of background material on the learning of subsequently presented material apparently seems to operate only when the latter material is sequentially dependent on the prior background material Thus in classroom learning tasks it is important to distinguish between (a) sequentially related materials that are sequentially *dependent on prior learnings and* (b) *sequentially* related ma terials that are sequentially *independent* of such learnings When we say that materials are sequentially related, we merely imply that in terms of the logic of subject matter organization, it is more reasonable for one set of materials to precede another than vice versa Sequential *dependence*, however, also implies that the learning of the later material actually presupposes knowledge of the earlier material and is impossible without it In sequentially *independent* situations on the other hand knowledge of the earlier material is not required for learning the later material the latter set of material, is other words is self-contained and can be learned adequately by itself without any reference to the previous set Such sequential independence is frequently brought about in sequentially related lessons by including in the second lesson a synopsis or review of all of the material from the first lesson that is absolutely essential for the understanding of the second

The effect of consolidating knowledge of the first of two sequentially related but sequentially *independent* passages on ability to learn the second was recently investigated (Ausubel and Youssef, 1966) The first passage was concerned with the normal physiology of pubescence and the second with clinical (pathological) aspects of pubescence It was found that greater knowledge of the passage dealing with the normal physiology of pubescence did not facilitate the learning of the sequentially related but sequentially independent (self contained) passage dealing with clinical conditions of pubescence Degree of knowledge of the normal physiology passage was manipulated by permitting subjects zero, one, or two readings of this passage prior to studying the clinical passage This finding was attributed to the current availability in the clinical passage of the minimum background material of normal physiology necessary for understanding the clinical material Under these conditions, the stability and clarity of both the directly relevant and of the collateral background material apparently became non determinative factors in learning the new material[7] M D Merrill (1965) and M D Merrill and L M Stolurow (1965) obtained substantially equivalent results using programmed materials

One can best interpret these findings perhaps by comparing them to the results one might have anticipated with sequentially dependent passages and the presumed reasons for same In a sequentially dependent situation one would expect degree of retained knowledge of early background material crucially to affect learning of the later material by providing relevant ideational scaffolding for it Hence, if such relevant ideational scaffolding were available and were clear and stable, it would provide a better foundation for new learning and retention than if it were not available, or, if

[7] As previously suggested however prior consolidation would probably enhance the long term *retention* of the new material under these conditions

available, were not clear and stable Repetition of the early background material is one of the factors that enhances its stability and clarity, and hence should facilitate the learning of sequentially dependent later material

However, when the directly relevant ideational scaffolding from the first passage is included in the second passage, and is thus *currently* available for the learning of that second passage, the fact that the learner has been exposed to the same relevant material in another context (and that his knowledge of it had thereby become consolidated) apparently becomes a nondeterminative factor in learning the second passage, and the collateral background material is in any case, of too tangential a nature to constitute relevant ideational scaffolding and hence to affect significantly the learning and *immediate* retention of the second passage It is quite possible, of course, that consolidation of the first passage would result in superior *delayed* retention of the second passage

These findings have some obvious implications for professional education which would of course, have to be validated by direct research evidence They suggest that much preprofessional education does not enhance professional competence as such, that we might be able to produce physicians, engineers, teachers and so forth, who are just as competent professionally without giving them an elaborate series of preprofessional courses provided that the basic minimum of relevant preprofessional material necessary for understanding professional content were included within and made part of professional instruction These preprofessional courses can naturally be defended on other grounds—the broadening of the individual s intellectual horizons and general culture But if this latter function rather than the enhancement of professional competence were actually their main justification it might be important for educators to revise their concept of professional education, particularly today when so many persons must be retrained quickly for new professional fields.

## Distribution of Practice
### *Effect on Learning and Retention*

The distribution of practice has long been a favorite topic of research and theoretical inquiry in the psychology of learning In fact more empirical evidence is available regarding the effects of *distributed practice on learning* and retention than regarding the comparable effects of simple frequency of practice Generally speaking the evidence supports the conclusion that distributed practice is more effective than massed practice for both learning and retention The relative efficacy of distributed practice however, depends on such factors as the age and ability of the learner and the nature, quantity, and difficulty of the learning task The advantages of distributed over massed prior relevant learning, and to length of the retention interval *Rehearsal*, a psychological variant of perseveration involving implicit practice, does not *require any unparsimonious neurological assumptions, and may very well* explain part of the effect of distributed practice in certain instances, but it definitely does not offer a complete explanation of the value of distributed practice, because the provision of inter trial rests has also been shown to facilitate learning in animals, in motor activities where rehearsal is im probable, and in practice schedules where rest intervals are filled with sleep (Spight, 1928) or other activities precluding rehearsal (Hovland, 1938, 1939, 1940a,b, 1949)

Fatigue or boredom (manifestations and causes of work decrement) do not provide very satisfactory explanations of the effects of distributed practice because few learning tasks in the laboratory are long or strenuous enough to give rise to either phenomenon Neither aspect of work decrement, furthermore, can account for the differential learning task and temporal position findings associated with distributed practice A somewhat more sophisticated work decrement explanation couched in terms of reactive inhibition" (the postulated self inhibitory potential produced by a given response following its elicitation, which supposedly dissipates with rest), is hardly more en lightening, inasmuch as the postulated mechanism of reactive inhibition invokes a purely hypothetical behavioral or neurophysiological process that has not been independently validated and is merely metaphorically descriptive of the empirical facts it purports to explain (the facilitation of learning when practice trials are distributed), the theory tends to be circular Motiva tional theories stress the decline in interest and drive accompanying fatigue or boredom, and are vulnerable, of course, to the same criticisms that have been applied to the latter theories

Forgetting theories are both theoretically most cogent and most in accord with the experimental evidence They specify the following ways in which inter trial rests can facilitate later learning and/or retention trials (a) If it is true that on any given trial repetition primarily strengthens those components of the learning task that are yet unlearned, the forgetting of previously learned components that occurs between trials in distributed practice schedules makes it possible for these latter components as well as for the yet unlearned components to profit from the strengthening effect of later trials (b) Rest provides an opportunity both for the dissipation of the initial confusion and resistance characterizing initial learning shock, and for the forgetting of interfering (wrong, alternative, competing) responses or meanings (Underwood 1961) The dissipation of initial learning shock here is comparable to that underlying the reminiscence effect in retention, except that it occurs in relation to numerous rest intervals rather than to a single rest interval whereas the dissipation of the inhibition caused by incorrect competing alternatives reflects the differentially faster rate of rest intervals It includes the following variables (a) the relative proportions of study trials (presentation of the material) and test trials (recitation or recall) (b) the nature of the response overt or covert constructed or multiple choice verbatim recall or reformulated prompted or unprompted (c) whether practice trials are so organized that each trial encompasses either the learning task as a whole or merely parts of same and (d) whether the number of repetitions and the rate of presenting new material is or is not related to the success of prior performance

### *Recitation versus Recapitulation*

In reception learning where the learning task is to internalize presented materials (facts principles arbitrary associations) so that they are available for later reproduction the learner may either be presented with numerous study trials or repetitions of the task or he may elect or be required to spend varying proportions of the total practice time in attempting to recall (recite) the material in test trials with or without the benefit of prompting The relevant research findings support the conclusion that whereas increasing proportions of recitation tend to facilitate *rote* learning and retention (Forlano 1936 Gates 1917 Hovland Lumsdaine and Sheffield 1949) (retention more than learning) the facilitating effect of recitation on *meaningful* learning and retention is both less striking and more equivocal (Gates 1917 Michael and Maccoby 1953 H A Peterson 1944)

The effectiveness of recitation particularly for rote material may be attributed to several factors First since the attempt to recall presented material actually tests whether and to what extent internalization (learning) has taken place the feedback that is provided in the next trial is therefore a much more significant factor after recitation than after recapitulation it indicates explicitly and systematically what the correct associations or meanings are in relation to the internalized learning that has already taken place Under these circumstances all of the effects of feedback—as an incentive condition as cognitive confirmation correction clarification and evaluation of the adequacy of learning and as reinforcement following reduction of cognitive and ego-enhancing drives—are considerably intensified

A closely related immediate consequence of feedback in this context is that as a result of discovering which parts of the learning task have not yet been sufficiently mastered the subject is better able to focus his attention and effort selectively on these latter aspects Second the more active kind of participation involved in recitation than in rereading implies greater learning effort which in addition to exerting a general facilitating influence on learning differentially salvages items at or near threshold strength and leads to more active and meaningful organization of the learned material (use of rhythm mnemonic devices and conceptual organizers) Lastly the condi tions of recitation more nearly resemble the conditions under which the learning will eventually be exercised than do those of recapitulation

For rote learning, where prompting is used, recitation is most effective if it is introduced after only a few study trials (Skaggs, and others, 1930) Without the benefit of prompting, however, recitation is more advantageously introduced at a later stage of practice (L O Krueger, 1930, W C F Krueger, 1930) Recitation apparently cannot prove helpful until enough material is learned so that a test trial can provide almost as much practice as a study trial, but if prompts are furnished to fill in gaps of knowledge, recitation obviously becomes feasible at an earlier point in a series of practice trials Thus the principle governing the optimal temporal position for introducing recitation is similar to the principle determining the optimal spacing of reviews if, on any given trial, the learner himself has to provide, from what he has previously learned, the stimulus material to be used for that trial (if he is given a test trial), the temporal arrangements must be such as to ensure the existence of sufficient learning or retention, respectively, to make practice or review profitable If, on the other hand, the learning task is presented to the learner in whole or in part, sufficiency of learning or retention is a less important consideration than Jost's laws

The markedly reduced effectiveness of recitation with respect to meaningful learning and retention is not difficult to understand To begin with, the logical sequential structure of connected meaningful discourse makes implicit recitation possible during the same trial, that is, in the course of rereading subjects typically tend to anticipate the remembered facts and propositions that follow logically from the material they are currently perusing In the case of meaningful material, also where the achievement of understanding is both a reward and an incentive in its own right, less effort is required for learning, and the incentive and ego enhancement values of feedback are less important Explicit testing is similarly less necessary for the confirmation, correction, clarification and evaluation effects of feedback in view of the fact that the internal logic of the material partly provides its own feedback—enables subjects to appreciate whether they have grasped meanings correctly and, in any case, implicitly to test their understandings against the next presentation of the material Finally, meaningful learning tasks benefit less from the organizing effects of recitation since they possess an inherent organization of their own Nevertheless, recitation can still facilitate meaningful learning—even when conducted early in the course of learning and without the use of prompts

### *Nature of the Response*

OVERTNESS Closely related to but not completely coextensive with the recitation recapitulation issue is the problem of whether the subject's mode of response during practice is overt or covert Overtness of response does not necessarily imply recall or construction as does recitation, but merely some measure of activity and externality (observability) Hence, either reading, listening to, or "mentally composing" answers to questions can be regarded as 'covert' responses, whereas both the construction of an appropriate answer and the selection of a suitable multiple choice alternative must be categorized as 'overt' Admittedly, however, constructed responses rank higher on a scale of overtness than do selected responses

The overt-covert dimension of practice has been explored principally in relation to a limited variety of automated instruction contexts—those involving meaningful learning, using programs of short duration, and, for the most part, requiring short term retention The research findings, under these conditions, indicate that subjects who respond convertly not only learn and retain verbal material as well as or better than subjects who construct their responses, but also do so more efficiently in terms of learning time[10] (Della Piana, 1961, Evans, Glaser, and Homme, 1960c, Goldbeck and Briggs, 1960, Goldbeck, Campbell, and Llewellyn, 1960, Krumboltz, 1961, Lambert, and others 1962, Pressey, 1962a, Roe, 1960, Silberman 1962, Silverman and Alter, 1960, Stolurow and Walker, 1962, Wittrock, 1963d, Yarmey, 1961) Overt selection of multiple choice answers, for instance, by pushing a button, is similarly no more effective than listening to or reading the correct under lined answers (Kaess and Zeaman, 1960, Keislar and McNeil, 1961; McNeil and Keislar, 1961) Under certain circumstances, however, (see below), overtness of response may facilitate learning and retention

In trying to understand these findings and to reconcile them with the research on recitation, it is necessary to consider the various ways in which overtness of response influences, or allegedly influences, learning and reten tion In the first place, it is self evident that overtness of response facilitates perceptual motor learning in instances where the overtly practiced response itself is one of the objects of learning (that is, part of the learning task) But where the overt response (for example, writing pressing a lever) is already a well-established component of the learner's response repertory and con stitutes merely a nonspecific means of responding to test questions, it is obvious that the response acqusition advantage of overtness is irrelevant and that overt responses are more time consuming and less efficient than their covert counterparts (Gagné, 1962b, Walker and Stolurow, 1962)

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[10] J D Krumboltz and R G Weisman (1962a) found the overt response mode more effective in delayed (two-week) retention, but M C Wittrock (1963d), using a one year retention criterion failed to confirm their findings W A Hillix and M H Marx (1960) reported that subjects who actively made their own trial and error responses in learning light circuits learned less efficiently than subjects who observed others making the very same responses R A Goldbeck and V N Campbell (1962) on the other hand found the *covert* response mode differentially more effective in delayed versus immediate retention

Second, it is widely asserted that behavior must be emitted in order to be properly reinforced through drive reduction (J G Holland, 1960, Skinner, 1958) Nevertheless, although this notion is a key assumption of the more orthodox brands of behaviorism there is little theoretical justification for believing that associations and response dispositions (sets) cannot be similarly reinforced

Third, overtness of response plainly makes more explicit testing of knowledge possible which, in turn enhances the cognitive drive reduction and motivational effects of feedback This consideration is probably very important for rote learning, and undoubtedly accounts for much of the value of recitation when rote materials are used, but, for reasons already specified, it has little applicability to meaningful learning Thus since practically all of the research in this area has been conducted with potentially meaningful programmed materials it is not surprising that the findings have been almost uniformly negative The facilitating effect of overtness of response on meaningful learning is further reduced in an automated instruction context inasmuch as the provision of feedback tends to make relatively little difference when the error rate is low (Evans Glaser, and Homme, 1960a) if because of small step size (slow rate of introducting new material), the subject's responses are almost invariably correct in any case he obviously does not stand to profit very much from the potentially facilitating cognitive effects of feedback In support of this interpretation is the fact that overtness of response is differentially more effective for difficult than for easy programmed material (Goldbeck, 1960, Goldbeck and Campbell 1962) and for intellectually less able than for intellectually more able students (Wittrock, 1963d) Suppes and Ginsberg (1962b) report that overt correction of error facilitates mathematical concept learning in 6 year old children, but from their data it is not clear whether the overtness of the correction or merely the correction procedure itself is the determinative variable

Meaningfulness of material, as previously explained, also negates a fourth possible reason for the effectiveness of overt responses—the fact that the latter imply greater activity and hence greater effort and more efficient organization of learning[11] It is interesting to note in this connection that when overtly and convertly responding subjects do not differ in motivation, they also do not differ in learning outcomes (McNeil and Keislar, 1961) This suggests but does not confirm the possibility that the facilitating effects of overtness when they do occur are partly mediated by motivational variables

Lastly, overt response during practice could conceivably facilitate learning by resembling more closely than covert response the response mode

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[11] According to J G Holland (1960) automated instruction even leads to a more active type of covert learning inasmuch as the material stands still instead of moving past the learner (as in a book or lecture) when his attention wanders

that is typically required in the criterial situation In an empirical test of this hypothesis however, response mode had no more effect on learning outcomes when the overt response was directly relevant to the behavior sampled on the post test (Wittrock 1963d) than when such relevance was lacking (Keislar and McNeil 1962)

CONSTRUCTED OR MULTIPLE-CHOICE The rationale for constructing rather than selecting answers during practice trials is precisely the same as that already specified for overtness of response (see above) plus the fact that exposing subjects to wrong answers presumably engenders and strengthens undesired competing responses (Skinner, 1958) These considerations, of course apply primarily to the learning of rote materials both because overtness of response is not particularly advantageous in meaningful learning (see above) and because the presence of competing responses affects meaningful learning differently than it does rote learning In the case of arbitrary verbatim learning the increased availability of competing responses is self-evidently harmful inasmuch as the desired arbitrary response is correct by definition and only has to be discriminated from similar rote responses that *actually* occur in recent proximity (rather than from all other logically plausible alternatives) in these circumstances furthermore one response is inherently just as plausible as another In the case of meaningful learning however where the new learning task largely consists of discriminating the correct meaning from other relevant alternatives and where built in criteria exist in cognitive structure and in the learning material itself for assessing relative degrees of plausibilty identification of the relevant alternatives constitutes the first step in enhancing the discriminability of the newly presented ideas

The clarification of meaningful new ideas in other words is primarily a process of differentiating the propositions in question from related established propositions in cognitive structure and from other plausible alternatives in the learning material (Pressey, 1962a 1962b) But before the comparative and evaluative aspects of such differentiation can be successfully undertaken it is first necessary to identify as precisely as possible the nature and source of the confusion that is to make explicit the various relevant alternatives [12] S L. Pressey's adjunctive auto-instruction (1960) uses multiple choice items to sharpen meanings *after* initial presentation and learning of the material N A Crowder (1960) on the other hand employs

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[12] That learners can profit from the exposure to and mistaken choice of wrong alternatives is shown by the fact that the percentage of correct answers increased on retest one month later for subjects in an experimental group who were given auto-instruction with multiple choice items after studying the learning task (R S Jones, 1950) This increase did not occur in the case of control subjects who did not receive any auto-instruction

the multiple choice format as part of the programming procedure itself ("intrinsic programming") the subject chooses one of several presented alternatives for a given test item and, depending on the particular wrong alternative he chooses, is then given a differential set of corrective materials which both explain the nature of his error and retest him for evidence of clarification

Research on the relative efficacy of constructed and selected responses (Briggs, 1958, Coulson and Silberman, 1960a, Evans, Glaser and Homme, 1960b, Roe, 1960) generally indicates that the two response modes are not significantly different in terms of learning and retention outcomes, but that the constructed mode is less efficient (requires more time) Since all of the above cited studies used meaningful programmed materials to which the advantages of the constructed response are least applicable, it is not surprising that the latter response mode was not shown to be superior In the one study reporting a significant difference in favor of constructed responses (Fry, 1960), it is notable that the learning task (Spanish vocabulary) was both more rote like and relatively difficult (high error rate) In another study, the constructed response mode proved superior only in relation to technical versus general items (J P Williams 1965) On the other hand, the hypothesized superiority of the multiple choice format for the learning and retention of meaningful materials also failed to be empirically substantiated by these studies It is conceivable, however, that the discriminability advantage inherent in the multiple choice response mode was counteracted by the greater learning time and effort involved in constructing responses

PROMPTING AND GUIDANCE The learner s responses during the course of practice may be completely unaided on the one hand, or receive the benefit of varying degrees of external assistance, on the other The nature and significance of such assistance obviously differ greatly depending on whether reception or discovery learning is involved In a discovery learning situation, assistance takes the form of *guidance*—providing cues which detract from the learner s opportunity for autonomous discovery Hence, guidance refers to and affects the reception discovery dimension of learning The provision of complete guidance is tantamount to presenting the learner with the essential content of the learning task (reception learning), whereas the absence of any guidance whatsoever requires completely autonomous discovery The degree of guidance furnished in most instances of discovery learning typically falls between these two extremes Guided discovery, for example, often consists of (a) Socratic or rhetorical questioning (Larson, 1963), (b) the arrangement of a hierarchical series of examples or problems for the learner, graded in difficulty which when completed, lead almost inevitably to the correct principle or generalization (Beberman, 1958), (c) the provision of a general rule without examples or the provision of worked examples without a rule (Wittrock, 1963c), (d) furnishing verbal directions that guide discovery (Gagné and Brown, 1961, Gagné, Mayor, Garstens, and Paradise, 1962), and (e) providing a demonstration, special exercises, or didactic instruction that highlight underlying substantive principles, correct form critical cues, or efficient strategies of attack (T Anderson, 1942, Cox, 1933, Davies, 1945, Goodenough and Brian, 1929, May and Lumsdaine, 1958, Vander Meer, 1945) All of these latter methods have proven more effective than either *complete* discovery or reception learning, particularly in the retention and transfer of problem solving skills

In a reception learning situation, external assistance takes the form of *prompting* during the test trials This assistance does not affect the autonomy of discovery, since the content of the learning task is wholly presented in any case, but does influence the autonomy of reproduction The learner is assisted, in whole or in part, to reproduce previously presented material which as yet has not been internalized above the threshold of availability If the entire and explicit substance of the information demanded by the test item is furnished the stimulus support can be regarded as a *prompt*, if the stimulus support is less complete and explicit during the test trial, it can be considered a *cue*

Prompting is more necessary and effective in the earlier stages of reception learning because at this time the learner has not yet internalized sufficient material to receive much practice benefit from unaided recitation (Briggs, 1961, Della Piana, 1961) Furthermore, the provision of prompts at this early point of practice can prevent guesswork and the learning of errors (incorrect competing responses) and thus obviate the necessity for costly unlearning For such reasons, prompting is more efficacious than confirmation (feedback) for relatively short periods of practice in reception learning (Briggs, 1958, 1961, Cook and Spitzer, 1960, Hovland, Lumsdaine, and Sheffield, 1949, Kaess and Zeaman, 1960, Silberman, Melaragno, and Coulson, 1961 a and b, L. M Smith, 1962) During the later stages of practice, however, these considerations are obviously less relevant In addition, it is important that the conditions of practice gradually begin to approximate the desired (unprompted) end point of the learning product Hence, as the amount of correct learning increases, both reduction of the completeness and explicitness of the prompts (J G Holland, 1960, Israel, 1960, Lumsdaine, 1961, Popp and Porter, 1960) and their replacement by confirmation (Angell and Lumsdaine, 1960, Lumsdaine, 1961; Stolurow, 1961b) are advantageous for further learning On theoretical grounds it also seems plausible that prompting could be profitably dispensed with earlier in the case of meaningful than of rote reception learning because of the more rapid rate of acquisition and the different role played by competing responses

A review of short term studies of the role of guidance in meaningful discovery learning leads to the conclusion that guided or semi autonomous discovery (either providing the learner with a verbal explanation of the *underlying principles and permitting him to apply them autonomously* to specific examples or encouraging him to discover the principles himself after working a carefully graded series of relevant problems) is more efficacious for learning retention and transfer than is either completely autonomous discovery or the provision of complete guidance M C Wittrock (1963c) and Wittrock and P A Twelker (1964) further substantiated this conclusion recently in well controlled studies in which college students were taught to decipher transposition codes Although more retention and transfer[13] occurred when the rule was provided than when it was not provided an intermediate type of guidance (furnishing either the rule itself or a worked example of it) was more effective than furnishing both rule and worked example or furnishing neither rule nor example The provision of rules was more effective in all instances than the provision of worked examples *Guidance under these circumstances apparently sensitizes the* learner to the salient aspects of the problem orients him to the goal and *promotes economy of learning by preventing misdirected effort*[14]

Some opportunity for autonomous discovery is obviously necessary in those instances where the object of learning is not merely the acquisition of knowledge but also the development of skill in formulating general principles and in applying them to particular problem situations Verbally presented principles it is true are transferable to such situations even if they

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[13] This superiority of guided discovery over reception learning is partly reflective of an experimental artifact Since criterial tests in this experimental design invariably involve discovery learning the guided discovery group enjoys the advantage of transferable discovery experience (problem solving strategy of attack) in the learning trials This interpretation is especially pertinent to G L. Larson s (1963) study in which a guided discovery group obtained higher scores on a transfer test than did either a complete discovery or a no discovery group despite the fact that *all three groups performed almost identically on an immediately preceding* delayed retention test

[14] It should be noted that even though subjects who learn by the complete or guided discovery methods enjoy the advantage of transferable discovery experience from learning to criterial trials they are in another sense at a disadvantage compared to the reception learning group with respect to opportunity for acquisition retention and transfer Insofar as they fail in many instances to discover the principles that are simply presented to the latter group they necessarily manifest less ability to demonstrate acquisition *retention* and transfer Larson *(1963) controlled* this variable by presenting the discovery groups a summary of the correct principles *after an initial period of autonomous or guided learning Nevertheless he found* that the guided discovery group was still inferior on the acquisition trials since the experimenter s verbalization of the principles interfered with the consolidation of intuitive principles emerging during the training

are not self-discovered, but the ability to solve a particular class of problems efficiently also presupposes experience in coping with the distinctive features of that class of problems in hypothesis-formulation and testing in the strategy of application, in identifying fruitful approaches that minimize costly risk and unnecessary cognitive strain, in using systematic and economic methods of inquiry, and in maintaining a flexible and meaningful learning set Actual discovery experience is even more important in trial and-error learning and in the learning of perceptual motor skills Adequate learning in these circumstances also requires that the individual learn what *not* to do, and for this he needs first hand experience in making mistakes and correct ing them Thus although appropriate guidance helps the learner avoid unnecessary error in the early stages of practice, its value tends to diminish as it increases in amount or extends into the later stages of practice (Carr, 1930, Gates and Taylor, 1926) Since he must eventually perform the learning task unaided, he must also avoid becoming overdependent on guidance

In conclusion, the unquestioning faith which advocates of incidental learning have in autonomous unguided discovery is justified neither by logic nor by research evidence In the first place, laboratory and problem solving exercises are not inherently or necessarily meaningful They may lead to little or no meaningful learning if a student s learning set is simply rotely to memorize type problems or techniques of manipulating reagents and symbols, and if he has inadequate background in or appreciation of the substantive and methodological principles underlying specific problem solving or laboratory procedures

Second, what is typically called 'the discovery method is really a contrived type of discovery that is a far cry from the truly autonomous discovery activities of the research scholar or scientist Pure discovery techniques could lead only to utter chaos and a waste of time in the classroom, inasmuch as immature students generally lack sufficient subject matter sophistication both to formulate workable problems and to devise appropriate and relevant research methods Before students can "discover generalizations reasonably efficiently, problems must be structured for them in such a way as to make ultimate discovery almost inevitable

Third, numerous short term studies have demonstrated that guided discovery is more efficacious for learning retention, and transfer than is either completely autonomous discovery or the provision of complete guidance However, these findings do not necessarily indicate that guided discovery is more effective for teaching subject matter content than is simple didactic exposition For one thing the solving by a naive subject of a few novel problems in a laboratory setting is hardly comparable to the learning of a large body of sequentially organized material by a learner with varying degrees of subject matter sophistication The problems used in laboratory studies are deliberately chosen on the basis of their relative unrelatedness to previously acquired knowledge For another, even contrived discovery techniques are typically more time consuming than expository teaching Much also depends on the relative time cost of the two approaches, on the cognitive maturity of the learner, on his degree of subject matter sophistica tion, on the nature of the learning task (descriptive information, representa tional equivalents, or principles that are discoverable by stating and testing hypotheses), and on whether the objective of the learning experience is to acquire knowledge, enhance problem solving ability or obtain insight into scientific method

Lastly, guidance in the form of prompting has been shown to be very helpful during the early stages of learning At this point in the learning process the learner has not yet mastered sufficient material to receive much practice benefit from unaided recitation Further, the provision of prompts can prevent the learning of errors and thus obviate the necessity for costly unlearning

VERBATIM RECALL VERSUS REFORMULATED RESPONSE In measuring the learner s comprehension and retention of meaningful verbal content, test items can be appropriately constructed either to encourage verbatim recall of the presented material or to lead him to reformulate his understanding of the material in terms of his own vocabulary and ideational background Although explicit empirical evidence is lacking on this issue the reformula tion approach has at least three theoretical arguments in its favor It not only constitutes a more valid measure of genuine understanding but also requires the more active participation of the learner in the testing situation and tends to discourage the adoption of a rote learning set in future learning efforts Other ways of accomplishing the same purposes in a formal testing context include the use of a multiple choice format employing application or problem solving items and measuring ability to learn a new set of propo sitions presupposing mastery of the content being tested In a less formal testing context the substitution of appropriate recitation trials for study trials tends to encourage reformulation rather than verbatim reproduction

## *Whole versus Part Learning*[15]

Whether it is more effective to practice a given learning task as a whole or to practice various component parts separately, depends on the interaction between a large number of complex variables Each method possesses certain

[15] Because of the voluminous and somewhat antiquated character of the re search literature in this area older studies are not cited Excellent reviews of the literature can be found in J A McGeoch and A L. Irion (1952 pp 499 507) and R S Woodworth (1938 pp 216 223)

type program the successful learner merely proceeds to the next set of items and the unsuccessful learner is given another easier series of items or a differential set of corrective materials related to the nature of his errors Lastly in either type of program size of step may be increased on subsequent items for the successful individual and decreased for the unsuccessful individual The nondifferential program in which all learners proceed through the same sequence of steps is conventionally referred to as linear, in contrast to the branching or multiple track type of differential program Available research evidence regarding this issue is far from being definitive The weight of the evidence suggests that branching programs requiring either simple repetition of incorrectly answered items or more differential corrective exercises are not only more efficient in terms of learning time (Briggs, 1958, Coulson and Silberman 1960a) but also result in learning outcomes that are either equal to (Beane 1962, Briggs 1958 Coulson and Silberman 1960a, S R Meyer, 1960a Silberman Melaragno and Coulson 1961b) or better than (Coulson and others 1962 Holland and Porter 1961, Irion and Briggs 1957) those of linear programs

On purely theoretical grounds the branching procedure should be superior to the linear procedure because it ensures mastery (consolidation) of a prior item of knowledge in a sequentially organized program before the learner can proceed to the next step in the sequence It accomplishes this objective by adapting both to *intra* individual differences with respect to the relative difficulty level of different portions of the program, and to *inter* individual differences in general intellectual ability and in particular subject matter sophistication The branching program in other words, requires both that *all* learners devote selectively greater learning effort to those items they find more difficult and that generally less able learners, on the average, take more practice trials than generally more able learners in mastering a given unit of material It also takes into account the particular reasons or misconceptions underlying errors in each individual, and endeavors to correct rather than to ignore them Thus quite apart from, and in addition to the effect of consolidation on sequentially dependent learning differential practice and feedback result in greater original learning of each component item in a related series of learning tasks

B F Skinner (1958) argues on the other hand that consolidation can be assured for all practical purposes without requiring repetition of incorrectly answered items by using a linear program with small task and step size and correspondingly low error rate Under these circumstances differential programs are allegedly unnecessary for different ability levels since even low ability students do not make an appreciable number of errors and high ability students can simply move through the program more rapidly C B Shay s (1961) study provides some support for this position by indicating that differential adjustment of step size to ability level does not sig nificantly enhance learning outcomes, his findings, however, have no bearing whatsoever on the repetition or correction issue In this latter connection it should be noted that previously cited evidence suggests that learning outcomes are adversely affected by lack of opportunity to correct errors This is particularly *true for low ability students who, despite an ostensibly low* error rate, actually learn considerably less than high ability students after completing the same linear program (Beane, 1962, Keislar and McNeil, 1961, Shay, 1961, Silberman, and others 1961b, Wittrock, 1963d) It is, therefore, unsafe to assume that dull students necessarily learn as much as bright students from the linear programs that they both complete, and that the only difference between them lies in the number of programs each group is able to master in a given unit of time

## General Conditions of Practice

In addition to frequency, distribution, and various specific aspects of method of practice (recitation versus recapitulation, nature of the response, whole versus part approach linear versus branching programs) many *general* conditions of practice undoubtedly influence learning and retention *outcomes These conditions include learning set, naturalness of the practice* setting, and degree of task homogeneity Unfortunately however, relatively *little* research evidence is *available regarding the effects of these important* variables

### *Natural versus Structured Settings (Drill)*

One of the strongest legacies of the progressive education movement and of Thorndikian educational psychology that still remains on the pedagogic scene is a confused and contradictory attitude toward structured practice or drill As a result, we often tend to minimize the value of drill—but *more in educational theory than in actual practice* The very term *drill* still evokes unsavory connotations in educational circles Actually, of course, drill is a necessary and *indispensable aspect of classroom learning In a* generic sense it refers to those aspects of the practice variable that affect learning outcomes J B Stroud puts the matter very well

> In our anxiety over the abuses alleged and real we have had a tendency to forget the fact that there are intelligent constructive uses of drill Drill is currently purported and by some who have been identified with education long enough to know better to be the handiwork of stimulus-response psychology
>
> In appraising drill as a teaching procedure it is well to remember that it is not mere repetition but repetition of the conditions of learning that is effective Drill can be effective ineffective or positively detrimental spirited or spiritless

Pupils do not necessarily learn just because they engage in drill In the best educational practice pupils are engaged in drill after the need of it has been demonstrated

Drill should be recognized for what it is worth and no more Perhaps no one has ever maintained seriously that drill in spelling will teach a pupil to think cultivate his character improve his social adjustment or make him more democratic. Other provisions are made for these aspects of his education By drill in spelling he does learn to spell The cultivation of his rational abilities or of his personality be it ever so well done is not sufficient to teach him to spell

Undoubtedly there are many undesirable features of drill work in our schools It should not be allowed to become monotonous Excessive and unessential written work should be avoided Because of its repetitive character pupils are likely to lose interest in it more quickly than in most other kinds of activity For this reason the length of such practice periods should be relatively short (Stroud 1942 pp 362 364)

The fetish of naturalism and incidental learning embodied in the activity program movement emphasizes these five points (a) unstructured and uncontrived learning situations (b) direct kinds of experience in a concrete manipulative sense (c) unintentional or nondeliberate learning effort (d) learning by autonomous unguided discovery and (e) exposure to diversified rather than repetitive experience The issue of intentional learning will be considered in Chapter 10 Some attention has already been given to the problem of guided learning and the matter will be considered at greater length in the discussion on learning by discovery in Chapter 14 The issue of task homogeneity will be considered in the next section

How desirable is it that practice takes place in natural (real life uncontrived) settings? Enthusiastic supporters of project and activity methods as we have already seen take a rather extreme position on this issue rejecting all kinds of highly structured practice (drill) and advocating in effect an incidental type of learning It is true of course (providing that all factors are equal) that learning is enhanced when the conditions of practice closely resemble the conditions under which the skill or knowledge in question will eventually be used Such learning is also less likely to be monotonous and enjoys the benefit of higher levels of interest and motivation Wholly natural settings however rarely provide the practice conditions that are either necessary or optimal for efficient learning Generally it is only during the latter stages of learning *after* component aspects of the learning task have already been identified and mastered in structured practice sessions that naturalistic dress rehearsals become feasible In the first place uncontrived learning experiences typically fail to include a sufficient number of properly spaced practice trials as well as adequate opportunity for differential repetition of particularly difficult components Second unstructured practice does not receive the benefit of skilled pedagogic selection presentation and organization of material of careful sequencing pacing, and gradation of difficulty, and of optimal balancing of intra task repetition, intra task variability and inter task variability Lastly, most learning effort is *enhanced by deliberate intention to learn*

The important teaching principle of initial simplification of difficult learning tasks for unsophisticated pupils runs counter to the doctrine of *natural or unstructured learning* Exposing an unsophisticated learner to all of the complexities of natural, unarranged data in the laboratory, or of subtle distinctions and qualifications in expository teaching, is the surest way of confusing and overwhelming him The use of artificial "crutches," gradation of difficulty, and slowing down the rate of presentation (Baker and Osgood, 1954, Lawrence and Goodwin, 1954, von Wright, 1957) are common forms of simplification in classroom learning

In an introductory course, simplification of content—*without* teaching wrong ideas that have to be unlearned later—is always justifiable and indicated *This can be accomplished by simply presenting more general and less complete versions of much of the same material that can be presented* subsequently in greater depth and at high levels of sophistication In an introductory course in biology, for example, it is less damaging to present *inadequate historical detail and experimental evidence than to obscure the* major concepts by providing excessive historical and experimental data

It is possible, for example, to present ideas relatively simply—yet correctly—*in an introductory course in high school biology by deleting a great* deal of the dispensable terminological, methodological, and historical detail, as well as many of the intermediate steps in argumentation, by telescoping or condensing *material, by eliminating tangential asides' and less* important qualifications, by limiting the scope of coverage, by omitting formulas, equations, and structural diagrams of complex molecules that *are actually meaningless to unsophisticated students, by keeping the level* of discourse general and simple, by writing lucidly, using terms precisely and consistently, and giving concise and familiar examples, by using schematically simplified *models and diagrams, and by bearing in mind that a* satiation point exists for any student An atypically high level of sophistication may sometimes be employed simply to illustrate the complexity of a given topic, *but in these instances students should be explicitly instructed* not to master the details

Many features of the activity program were based on the self-evident *proposition that the elementary* school child perceives the world in relatively concrete and intuitive terms and requires considerable direct experience with many concrete instances of a given set of relationships before *he can acquire* genuinely meaningful concepts and generalizations Thus, an attempt was made to teach factual information and intellectual skills through the medium of direct, manipulative experience in natural settings rather than through verbal exposition and drill

In older pupils however, once a sufficient number of basic abstract concepts is acquired new concepts are primarily derived from other verbal abstractions rather than from direct experience and new propositions are comprehended without any direct reference to or manipulation of concrete props In the secondary school therefore, it may be desirable to reverse both the sequential relationship and relative proportion between abstract concepts and concrete data Thus there is good reason for believing that much of the time presently spent in busywork laboratory exercises in the sciences could be more advantageously employed in formulating more precise definitions differentiating explicitly between related concepts, generalizing from hypothetical situations and so forth

### *Task Homogeneity*

Proponents of activity programs tend to favor task heterogeneity in practice That is they seek, in part to escape the opprobrium associated with drill by stressing diversity both in the types of learning tasks and in the examples of each type that are presented to the learner

Relative degree of task homogeneity is often an important practical consideration in the learning of skills and inductively acquired concepts and principles The issue is whether such learnings can be acquired most efficiently as a result of intensive practice with just a few exemplars, or as a result of less intensive practice with a large variety of exemplars We have already concluded in an earlier chapter that other factors being equal, the defining attributes of a given concept are learned most readily when the concept is encountered in many diverse contexts Such experience obviously lessens the particularity and enhances the generality of abstract knowledge and transferable skills It is important to qualify this conclusion, however, by pointing out that if this multi-contextual experience is acquired at the expense of attaining adequate mastery of the particular component tasks which comprise it its over all effect on learning is detrimental In learning general concepts principles and skills inductively experience with a particular exemplar has a positive transfer effect on other exemplars *only* if it is adequately consolidated and similarly it is only by mastering several exemplars in the same fashion that the total experience can be successfully utilized in formulating a transferable generalization Thus transfer in learning set problems requires mastery *within* a given type of problem, as well as experience with many variants of this problem type When compared with giving only one class (with eight problems) two classes (with four problems per class) may be enough of a variety to enhance transfer to new [problem solving] instances (Wittrock and Twelker 1964) Also if the supportive empirical instances of a concept (Kurtz and Hovland, 1956) or a proposition are too heterogeneous in content or sequence of presentation learning is impeded

It seems, therefore, that efficient learning of transferable skills and knowledge demands a proper balance between the overlearning of particular intra task instances, on the one hand and adequate exposure to intra and inter task diversity, on the other These two conditions of practice are complementary and mutually supportive rather than antithetical or mutually preclusive, although it is quite probable that their optimal proportions vary in different learning tasks Many cases of disability in particular academic skills can undoubtedly be attributed to overemphasis on the importance of diversified experience in unstructured learning situations with consequent insufficiency of practice and failure to attain mastery of the component habit exemplars from which the skill in question is derived Hence, we should not lose sight of the fact that the acquisition of general skills is dependent upon the prior consolidation of more particular habit exemplars [16] and that these skills are therefore not efficiently or satisfactorily established unless learners practice the underlying exemplars sufficiently to master them thoroughly Generally speaking, educators have tended to stress the importance of extensity as opposed to intensity in learning Actually, if a choice must be made it is preferable to know a few things well than to have a passing acquaintance with many A small quantity of consolidated knowledge is both useful and transferable, a large quantity of diffuse and unstable knowledge is utterly useless

Another obvious advantage of multi-contextual learning providing it does not interfere with intra task mastery, is that it prevents boredom and enhances the exploratory drive This is particularly true in the case of more intelligent learners less inter task variability is required to sustain the interest of duller pupils (Armistead, 1961) Learning set considerations bearing on desirable degree of inter task variability in practice will be considered in the next section

### *Learning Set*

The term learning set refers to current disposition to learn or perform in a particular way Hence, in its broader meaning it also includes the learner s disposition to learn in a rote or meaningful fashion Meaningful learning set as one of the major prerequisites for meaningful learning is obviously an important general condition of practice, but has already been fully discussed in another context

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[16] Skills are generally differentiated from habits (a) in being executed more deliberately and less mechanically and (b) in embodying a general capacity to perform a whole class of operations rather than mere facility in executing a particular exemplar of that class When a person becomes highly proficient at a given skill however the psychological distinction between skill and habit tends to vanish the entire class of operations then acquires nearly as much particularity as the former habit and becomes almost as mechanical in its execution

to take advantage of both the learning to-learn and the warm up components of learning set At the same time, however, enough heterogeneity of inter-task content should be introduced to prevent the mechanical perseveration of a given learning set, and to discourage rigidity of approach and the development of a rote learning attitude The need for multiple warm up periods is one of the chief disadvantages of distributed practice, and renders such distribution unfeasible in certain tasks requiring considerable sustained effort

## Knowledge of Results (Feedback)

On theoretical grounds, knowledge of results or feedback would appear to be an extremely important practice variable Nevertheless, because of serious gaps and inadequacies in the available research evidence, we possess very little unequivocal information either about its actual effects on learning or about its mechanism of action

As previously indicated, some knowledge of results is apparently essential for learning in those perceptual motor tasks where a variable or indeterminate response must be given to a constantly presented stimulus If, for example, the learner is repeatedly asked to draw a three inch line, he obviously cannot manifest any improvement unless he knows to what extent his efforts approximate the desired standard (E L Thorndike, 1931, 1932) In other instances, however, where *both* stimulus and response are provided (for instance, paired associate learning), or where the learner must simply comprehend and internalize the material presented to him, feedback facilitates learning and retention (Hershberger, 1964), but is certainly not indispensable for either outcome Feedback, furthermore, is not even indispensable for all types of perceptual motor learning In tasks such as gunnery, where appropriate responses or stimulus response connections are already well established, enhancing knowledge of results (for example, by sounding a buzzer whenever the learner is exactly on target) improves current performance but does not result in any transferable gain in learning (Gagné, 1962b)

### *Mechanism of Action*

An equally important issue, assuming that feedback is indispensable for some kinds of learning and has a facilitating influence on others concerns the mechanism whereby this facilitation is effected Behavioristically oriented theorists (J G Holland, 1960, Hull 1943, McGeoch and Irion, 1952, Skinner, 1938 1958, E L Thorndike, 1931, Trowbridge and Cason, 1932) tend to attribute the effects of feedback largely to reinforcement or

In the present context therefore we shall consider learning set only insofar as it reflects the influence of *recently prior* learning experience or activity This aspect of learning set reflects both (a) general methodological sophistication in approaching a given learning task or attacking a particular type of problem ( learning to learn ) and (b) an appropriate performance attitude or momentary state of readiness for engaging in a particular kind of activity ( warm up effect) Both of these components of learning set obviously contribute to positive transfer Thus irrespective of the kind of learning involved (nonsense syllables mazes poetry paired adjectives) practice on one task tends to facilitate the learning of another similar task providing that there is no conflictful overlapping of content between them (Thune 1950a Ward 1937) H F Harlow s learning let phenomenon largely reflects the cumulative influence of learning to learn as a result of successive intra and inter task experience with a particular type of discrimination problem Learning set is therefore a significant general condition of practice to bear in mind in ordering the distribution and sequencing of practice as well as the optimal degree of inter trial task homogeneity

It is important on theoretical grounds not to confound the learning-to-learn and warm up aspects of learning set. The former consists of relatively stable *cognitive* acquisitions concerned with the strategy of learning that are derived from past learning experience and which influence the actual content and direction of ongoing learning activity the latter consists of transitory readiness factors involved in the momentary focusing of attention mobilization of effort, and overcoming of initial inertia that are associated with being appropriately set to perform a given task. Warm up effects naturally are rather rapidly dissipated (C E Hamilton 1950) accounting at most for part of the inter task improvement in learning that occurs during the course of a single day s practice longer term improvement (from one day to another) must be accounted for solely in terms of learning-to-learn effects (Thune 1950b) A L Irion (1949) has shown that much rote forgetting is caused by the loss of set to recall that takes place during the retention interval By using a warming up (color naming) task during the rest interval he was able greatly to facilitate the retention of paired associates[17] In the case of meaningful retention warm up effects are also presumably operative but probably less conspicuously so than in rote retention

In programming potentially meaningful material it is obviously important to preserve sufficient commonality between successive learning tasks

[17] In the familiar retroactive inhibition paradigm the net decrement in retention that results from the interpolation of a similar task occurs despite the facilitating warm up effect of the interpolated task Evidently the general retroactive facilitation attributable to warm up is not great enough to overcome the specific interfering influence of similar content in rote learning

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### *Mechanism of Action*

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But the facilitating effects of feedback are hardly exhausted by these reinforcement and motivational mechanisms Knowledge of results also has other purely cognitive effects on learning It confirms appropriate meanings and associations corrects errors clarifies misconceptions and indicates the relative adequacy with which different portions of the learning task have been mastered Thus as a result of the feedback he receives the subject s confidence in the validity of his learning products is increased his learnings are consolidated and he is also better able selectively to focus his efforts and attention on those aspects of the task requiring further refinement

### *Rote versus Meaningful Learning*

On both motivational and cognitive grounds feedback probably has less facilitating effect on meaningful than on rote learning Since the achieve ment of understanding is a reward in its own right and requires less brute effort than rote learning it is less necessary in meaningful learning to invoke the energizing assistance of extrinsic motives and incentives Selective rein forcement of successful responses through drive reduction (gratification) is similarly less necessary for learning even if it were possible when logical considerations are applicable to the content of the learning task than when a purely arbitrary and verbatim connection must be established. The in ternal logic of the learning material also makes possible some implicit con firmation correction clarification and evaluation of the learning product *even in the absence of any explicit provision of feedback*

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[18] For a discussion of the significance of the distinction between emitted and covert responses insofar as the reinforcing effect of feedback is concerned see this chapter

[19] As will be indicated later however reinforcement probably occurs only in simple instrumental learning and in *rote* verbal learning—*not in meaningful learn ing* and where it does occur it is more likely attributable to lowering of thresholds of el citation than to strengthening of response tendencies

of the logic of the correct answer is still another dimension of the completeness of feedback that influences learning Subjects who are told *why* their answers are right or wrong learn more effectively than subjects who merely continue responding and receiving feedback until they obtain the correct answer (Bryan and Rigney, 1956) J M Sassenrath and C. M Garverick (1965) found that discussion of midsemester examination questions has a greater beneficial effect on final examination results than does either checking wrong answers from a list of correct answers placed on the blackboard or looking up in the textbook the correct answers to incorrectly answered questions The use of specific relevant comments in grading themes is also much more effective in improving the quality of later writing than is the use of perfunctory encouraging comments (Page, 1958) N A Crowder's 'intrinsic programming' includes explanation of the nature of the error as an integral part of the branching procedure In certain kinds of concept learning situations where many irrelevant cues are available, informing the subject when he is wrong facilitates learning more than does informing him when he is right (C Curry, 1960, Meyer and Offenbach, 1961, Meyer and Seidman, 1960, 1961), right' apparently gives less information than "wrong' under these circumstances because it also rewards irrelevant cues

Research findings regarding the immediacy and frequency of feedback are more equivocal Some investigators have reported that immediately given feedback has a significantly greater facilitating effect on learning than does delayed feedback (Angell, 1949, S R Meyer, 1960b, Sax, 1960); but neither J L. Evans, R. Glaser, and L E Homme (1960a) nor G Sax (1960) found a significant difference between the two kinds of feedback on learning and retention respectively Other investigators (Brackbill, Wagner, and Wilson, 1964) have even reported a positive relationship between delay of feedback and retention These findings are quite credible considering the role of feedback in meaningful verbal learning In any case, the evidence that errors made initially tend to persist despite repeated correction (Kaess and Zeaman, 1960), and that prompting is superior to confirmation (at least in the early stages of practice), suggests that, if at all possible, it is preferable to avoid errors in the first place rather than to correct them immediately.

Except for two studies (Auble and Mech, 1953, Sax, 1960) reporting no significant differences, continuously as opposed to intermittently administered feedback has been shown to be more effective in concept learning (Bourne and Haygood, 1960, Bourne and Pendleton, 1958, Chansky, 1960) In more sequential types of programmed instruction, however, the relative frequency of feedback does not appear to influence learning outcomes (Krumboltz and Weisman, 1962b, Lambert, 1962) N. M Chansky (1964) obtained best results with an intermittent type of information feedback and with a continuous grading procedure Whatever procedure is used, however, it is obviously advantageous to employ indicators of success that the learner can use autonomously for purposes of feedback and self evaluation, that is, indicators that are available to him outside the training situation (J Annett, 1959) In this way, he is not dependent for feedback on an external source such as the teacher

To summarize, feedback is not generally indispensable for learning, but, on both motivational reinforcement and cognitive grounds, should facilitate the learning process, more so in the case of rote than of meaningful learning However, the research evidence tends to be equivocal, particularly in relation to programmed instruction, because of the failure to control other relevant variables Further compounding the difficulty of interpreting the effect of feedback on meaningful programmed learning, is the fact that both low error rate and the possibility of implicit feedback reduce the facilitating potential of explicitly provided feedback

Chapter 9

# INSTRUCTIONAL MATERIALS

TASK VARIABLES INCLUDE, in addition to various aspects of practice considered in the previous chapter, *the nature of the task to be learned in meaningful fashion* the amount and difficulty of the instructional material, its internal logic and organization, the rate at which new ideas and information are presented, the magnitude of the transition between successive tasks or between component steps within a task, effective ways of presenting material, and the use of instructional aids and media, such as textbooks schematic models, educational television, audio-visual techniques programmed learning and laboratory methods In large measure, of course, the optimal organization and presentation of instructional materials involve an application of principles (progressive differentiation, integrative reconciliation sequential organization, spiral organization, consolidation the use of organizers and of pervasive, integrative themes, the concrete abstract dimension of cognitive development) already considered under cognitive structure and readiness variables Many of the issues implicated in the relatively recent curriculum reform movement exemplify an application of these principles to practical problems of curriculum development and organization

## Amount of Material Task Size

The amount of material contained in a given learning task, that is, the relative size of the task, is an important consideration in programming subject matter and in arranging practice schedules Task size influences the structure of the material and its difficulty, as well as the learner s motivation, and, as we shall see shortly, it is also a central issue in the field of automated instruction

The relative efficacy of different task sizes is closely related to the previously considered part whole problem in practice both because the total magnitude of the task confronting the learner is a significant factor determining his choice of approach, and because the part method obviously involves working with a smaller task size than does the whole method. Nevertheless, the two issues are hardly coextensive Task size is a much more inclusive issue than the choice of a whole or part strategy of practice Only relatively rarely, in choosing between different task sizes in programming subject matter, is one faced with a decision that is comparable to the choice between memorizing a poem as a whole or memorizing it by stanzas Al though component task units of a subject matter program are sequentially related to each other, they are more typically related in a derivative or correlative sense rather than as successive links of a chain that would have to be welded together if first learned separately

### *Meaningful versus Rote Learning*

In the case of rote learning, the paramount consideration in deciding upon task size is the disproportionate increase in learning difficulty that occurs as length of task (for example, number of nonsense syllables) increases beyond immediate memory span (Carroll and Burke, 1965, Lyon, 1914, 1917, Robinson and Heron, 1922) This disproportionately manifests itself in progressively increasing learning time per unit of material,[1] it tends to be more marked at lower rather than at higher levels of practice (McGeoch and Irion, 1952), when practice is massed rather than distributed (Hovland, 1940b, Lyon, 1917), and in slow as opposed to fast learners (L J Carter, 1959, H B Reed, 1924) For the most part, the disproportionality seems to reflect the greater opportunity for intra serial interference as the number of units in the task increases (L J Carter, 1959, McGeoch and Irion, 1952) To some extent, also, it reflects the subject s initial discouragement as he contemplates the magnitude of the task confronting him, as well as unnecessary repetition of already learned items as yet unlearned items in the longer list are being acquired (McGeoch and Irion, 1952) Length of rotely learned tasks, however, apparently has no effect on *retention,* apart from its effect on learning Thus, when lists of varying length are learned to the *same*

[1] When number of repetitions (trials) required for mastery is used as the criterion of learning difficulty the level of difficulty spuriously appears to decrease as the size of the task increases, that is longer tasks require fewer trials (Ebbinghaus 1913 Hovland 1940b) This is so because each repetition is counted as one trial irrespective of the length of time it takes

criterion of mastery and are similarly reinforced, they are equally well retained (L J Carter, 1959)[2]

In the case of meaningful learning the same simple disproportionality between increase in difficulty level and increase in task size presumably does not prevail The disproportionate increase in intra serial interference accompanying increase in task size, which obviously has an important inhibitory effect on the formation of arbitrary verbatim associations between discrete stimulus or stimulus response components, has little relevance for the kind of learning involved in the substantive relational incorporation of potentially meaningful material within cognitive structure Hence, although increasing the length of a meaningful learning task undoubtedly increases its difficulty, all other factors being equal, one might anticipate on theoretical grounds that the increase in difficulty would not be disproportionate to the increase in task size Much more important for difficulty of meaningful learning and retention than length of task itself would be the logical structure the lucidity, and the sequentiality of the material The optimal size of task that the learner could conveniently manage in a given trial would also depend upon such considerations as age, cognitive maturity, subject matter sophistication, intelligence, and motivation

Research evidence on the length difficulty relationship in meaningful learning is sparse and equivocal C N Cofer s data clearly demonstrate that learning time increases much less rapidly with increasing length of task when prose passages are learned meaningfully than when they are learned rotely (Cofer, 1941), but the precise relationship between length and difficulty in the former instance is, unfortunately, less clearly indicated D O Lyon (1914, 1917) found a disproportionate increase in learning time with increase in the length of meaningful prose passages (except for lengths between ten and fifteen thousand words), it must be remembered, however, that verbatim learning was required in his study Increasing the length of an instructional motion picture by adding more facts, while holding density (number of facts per minute), but not logical structure and continuity, constant, did not result in a proportionate increase in the amount of information learned, but apparently had no detrimental effect on retention (Vincent, Ash and Greenhill, 1949) Hence, much more definitive research studies are obviously needed before empirically warranted conclusions can be drawn regarding optimal task size in meaningful learning

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[2] Evidence indicating that longer lists are *better retained* than shorter lists under these circumstances (Robinson and Darrow 1921, Robinson and Heron 1922) undoubtedly reflects the overlearning of some items in the more frequently repeated longer lists Removal of paired associate items from a list after three correct responses tends to eliminate this difference in retention (Robinson and Darrow 1921 Robinson and Heron 1922)

### *Automated Instruction*

Relatively small task size is one of the characteristic features of the currently flourishing automated instruction movement In the teaching machine literature, task size is customarily subsumed under the term step size no distinction being made between degree of transition from one step or frame to another (step size) and the amount of material included in a single frame or presentation (task size) It is true of course, that if a given segment of material is simply divided into many small task units on the one hand, or into a few larger task units, on the other, task size and step size' are practically synonymous terms Actually, however, it is quite possible to vary each dimension independently, once task size is determined as described above, this can be done either by adding or deleting steps or by otherwise modifying the task units so as to increase or decrease the amount of overlap between them In the following discussion we shall consider each dimension as an independent variable

B F Skinner (1958) has presented a strong case for the prevailing practice of using small task units in programming subject matter By making learning easy and painless and guaranteeing success, this approach enhances the learner s self confidence and encourages him to persevere in his efforts Furthermore, by insuring a low error rate, it avoids the initial occurrence and hence the recurrence of misconceptions and wrong responses, maximizes positive reinforcement, and minimizes negative reinforcement Lastly, it makes possible immediate confirmation, clarification, and correction, and practically guarantees that consolidation of material prior in the sequence occurs before new material is introduced When larger task units are used, on the other hand, misconceptions cannot be corrected immediately after they arise and there is no assurance that the learner will consolidate prior learnings before proceeding to later sections of the material

Nevertheless the small task size approach in programming subject matter has many serious shortcomings Although concerned with meaningful learning it adopts a rote learning strategy in handling the task size variable, that is it places major emphasis on the length difficulty relationship, and ignores the logical structure of the material—both as a criterion of optimal task size and as a determinant of task difficulty in meaningful learning In terms of both the logical requirements of meaningful learning material and the actual size of the task that can be conveniently accommodated by the learner, the frame length typically used by teaching machines[3]

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[3] In his scrambled books N A Crowder (1960) departs somewhat from the small frame approach He believes in maintaining flexibility of task unit size so as to make possible the communication of complex information Hence he allows for task units of up to page size length

is artificially and unnecessarily abbreviated It tends to fragment the ideas presented in the program so that their interrelationships are obscured and their logical structure is destroyed As S L Pressey observes

> The student is shown this material one bit or frame at a time in the window of a mechanism or space of a programmed textbook He cannot readily look back at what he has been over or ahead to sense what is to come or discover any outline or structure in the material For effective reading for general understanding of main ideas, and for adequate study and review this procedure seems to be as clumsy as asking a person to apprehend a picture by letting him see in a set order only one square inch at a time
>
> Study of a complex and structured subject seems better begun by an overview of reading matter to display the structure and order the complexity A good book will show its structure in the table of contents and catalog its contents in the index with such aids the learner can easily move about in its numbered pages with only the flick of a finger using page headings and subheads in the text to guide him He may turn back and forth from table or graph to related text skip something already known review selectively for major and difficult points Only after first contact with a complex structured topic should a student turn to auto-instruction for review and differentiation of major points in material The auto-instruction will then assure the student when he is right and identify and correct any misconceptions—as a good teacher or tutor might then do Auto-instruction as an adjunct to the usual materials and methods of instruction would seem both more widely useful and more practicable than current efforts to replace textbooks and methods with radical initial programming (Pressey 1962a pp 31 33)

Further, just because task size is small and error rate is low, one cannot warrantedly assume that the learning of sequentially presented ideas is necessarily rendered easy and successful and that consolidation of existing material is therefore assured before new material is presented In fact, the very fragmentation of content may serve to ensure mastery of the component task units at the expense of understanding the logic of the larger segments of subject matter of which they are a part D G Beane, for example programmed geometric proofs so that

> most of the proofs involved less than seven steps but still required the student to keep in mind a sizeable amount of information The steps of the program were small enough that the student could usually answer the next question regarding a particular step in a proof without difficulty Evidence supporting this point of view is the relatively low error rate of approximately 8 percent for the low ability students on the linear program However this does not mean that the student necessarily had a good grasp of the logical sequence or plan of the whole proof This provides a real challenge to programmers of material concerned with involved logical arguments Insuring that the student can take the next step successfully in a program by sufficiently granulating the material and then arranging it systematically is no guarantee that he will understand the logical development involved Also the student will not remember very well the facts he does learn if he fails to

comprehend the logical structure and relationships of the concepts presented (Beane 1962 p 85)

That failure adequately to appreciate logical structure and relationships actually affects meaningful learning and retention adversely is shown by the fact that criterial post tests often reveal relatively little residual learning and retention as a whole despite a very low error rate while each fragmented unit itself is being learned

The desirability of avoiding unnecessary errors and misconceptions also does not imply advocacy of an artificial simplification of ideas that spares the learner from making the necessary distinctions required for making meanings more precise and for testing the adequacy of existing understandings Certain kinds of learning (for instance, problem solving acquiring perceptual motor skills), moreover, demand first hand experience in making and correcting errors R J Melaragno (1960) found that spaced negative reinforcement, induced by deliberately inserting ambiguous, error producing frames into a program, did not inhibit learning

Finally, many of the advantages attributed to the small task size format of teaching machines are not really inherent in small task size itself, but are reflective of small step size and careful sequential organization Both of these latter procedures, of course, are perfectly compatible with the use of larger task units When employing the larger task unit format, one can also help insure consolidation of earlier presented material within the same task by using appropriate organizers, by increasing the lucidity of presentation, and by maximizing sequential organization and reducing step size between component sections of the task unit

## Difficulty of the Material

The difficulty of the learning task obviously affects learning time, rate of learning (slope of the learning curve) and the amount of material that is learned and retained[4] These factors in turn, influence the efficiency of learning effort If the material is too difficult the learner accomplishes disproportionately little for the degree of effort he expends, if it is too easy, his accomplishments are disappointingly meager in terms of what he could have achieved were greater effort demanded of him As previously indicated, task difficulty is related to the size of the task unit, but can, nevertheless, be varied quite independently of task size

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[4] For example as the difficulty level of a nonsense syllable task increases the amount and rate of learning decreases the rate of improvement also becomes more uniform or linear rather than rapid at first and progressively slower (W C F Krueger 1946)

Task difficulty also affects learning efficiency in other ways than by influencing amount and rate of learning relative to the effort expended Excessively difficult material makes for an undesirably large number of initial errors and misconceptions that have to be unlearned, interferes with necessary intra task mastery and consolidation in sequential learning programs, and depresses the learner s self confidence, lowers his motivation, increases his anxiety and promotes task avoidance In meaningful problem solving situations, it typically induces perseveration, rigidity, blind trial and error and disorganized behavior (Klausmeier and Check, 1962) Inappropriately easy material on the other hand, fails to stimulate and challenge the learner adequately, fostering boredom and disinterest

Since the appropriate level of difficulty of a given task is always relative to the learner s age, cognitive maturity, subject matter sophistication, intelligence, and motivation it is best determined on an individual basis When learning tasks are suitably adjusted in difficulty level to pupils' current achievement level, there are no significant differences between low, middle, and high IQ groups in learning retention, and transfer (Klausmeier and Check 1962) Previously cited studies suggesting that fast learners retain more than slow learners because they learn more in a given unit of time, fail to take into account the fact that the difficulty level of the material used in these experiments was more appropriate for the faster learning group

## Step Size

Step size, that is, the relative magnitude of transition between task units is also an important issue in programming meaningful subject matter It can be reduced by increasing redundancy or overlapping of content, by making explicit reference to or comparisons with prior task content (integrative reconciliation), and by couching new material in terms of familiar concepts or experience When large task units are used, it is also meaningful to speak of step size between successive components of the task unit

The step-size variable is partly coextensive with the previously considered variable of task homogeneity or inter task variability Unlike task homogeneity, however, it is more concerned with the relative gradualness or abruptness of transition between the component tasks of a sequentially organized program than with relative degree of homogeneity or heterogeneity of the exemplars used to develop a given concept or proposition The relative effectiveness of different step sizes in a given learning program, therefore, is dependent in part, upon achieving an appropriate balance between considerations, such as conceptual generality, intra task mastery, learning to learn, warm up effect, perseveration, rigidity, and boredom, which are associated with both of these variables Hence, the choice of appropriate step size is likely to be quite specific to the particular learning task the conditions of learning, and the characteristics of the learner Small steps minimize the possibility of error (Evans, Glaser, and Homme, 1960c, Klaus 1961, Skinner, 1958), but are more time consuming (Coulson and Silberman, 1960, W Smith and Moore, 1962), they are also less necessary when potentially meaningful material and a branching type of feedback are used Furthermore, as S L Pressey (1962a) points out, they fragment the learning task without necessarily guaranteeing understanding of the task as a whole or of the relationships among its component parts, despite yielding a low error rate

Research on step size within the context of automated instruction has been confined to the small task unit format, and is generally inconclusive J E Coulson and H F Silberman (1960) found a small step program more effective than a large step program in terms of score on a criterial learning test, but less effective in terms of learning time, other investigators either found no significant differences between the two types of programs (Briggs, 1958, Shay, 1961, W Smith and Moore, 1962) or reported their findings in terms of the more equivocal criterion of error rate (Evans, Glaser, and Homme, 1960c) On the basis of their research N Maccoby and F D Sheffield (1961) recommend small step size for initial learning, with progressive lengthening of steps as subjects acquire facility in performing the learning task

## Pacing

Pacing generally refers to the rate of introducing new subject matter material as determined by the length of time interval between component task units Other subsidiary ways of influencing rate of coverage include (a) manipulation of step size (degree of overlap in content between successive task units, (b) increasing or decreasing the density (informational content) of task units,[5] and (c) regulating the number of intial repetitions and subsequent reviews given each task unit All of these latter manipulations, of course, eventually affect the number of task units covered in a given interval of time, and hence the rate of covering new subject matter Pacing in other words deals with the massing or distribution of different task units as opposed to the massing or distribution of trials of a particular task Considering the potential importance of this variable for the programming of school material, it has been the subject of surprisingly little research

Theoretically it would seem plausible that an optimal average inter

[5] An increase in the concentration of facts in an instructional film of specified length was not shown to result in a proportionate increase in informational learning (Vincent Ash and Greenhill 1949) However this finding may be partly explained by removal of the isolation effect

task interval exists for every kind of subject matter, given learners of specified cognitive maturity and subject matter sophistication Thus, it probably makes a difference, on the average, if seventy five hours are to be spent in learning a particular segment of material, whether this learning time is distributed over two weeks, one month, two months, or a semester First, sufficient time is necessary to recover from initial learning shock before proceeding to new tasks Second, the learner requires adequate time for contemplating the material in retrospect, for effecting integrative reconciliation, and for conducting adequately spaced reviews in conformity with Jost's laws Third, it is important to avoid excessive cognitive strain and a feeling of harassment, on the one hand, as well as unnecessary redundancy, lack of challenge, and boredom on the other Lastly, it is necessary to provide sufficient time for practice, particularly for slow learners, so that intra task mastery or consolidation can be assured before new tasks are presented

In any case, it is apparent that most individuals can be trained to comprehend meaningfully a much more rapid rate of orally or visually presented verbal discourse than that to which they are habitually accustomed. This is the principle underlying current methods of accelerating rate of reading and listening (Orr, Friedman and Williams, 1965) Whether material assimilated in this fashion is also retained as well as material presented at more conventional rates still remains to be demonstrated

On logical grounds because of individual differences in cognitive maturity intelligence subject matter sophistication, and motivation, it would be reasonable to expect that individualized pacing would be more effective for learning than the imposition of a uniform rate of coverage on all learners Using the quality of past performance as a guide, such individualization could then be regulated by either teacher or pupils, the former having the advantage of greater objectivity and pedagogic sophistication, and the latter possessing more direct information about cognitive strain and degree of challenge, although this information is admittedly contaminated in part, by such considerations as self indulgence Apart from the results of one study (Follettie, 1961), the limited experimental evidence available on the relative efficacy of self regulated pacing (Mitzel, 1962, Silberman 1962) does not indicate any superiority over teacher (or programmer) regulated pacing This does not mean, however, that differential or individualized pacing is not superior to uniform pacing

## Internal Logic of Instructional Material

The internal logic or logical meaningfulness of the learning task is obviously relevant for meaningful learning and retention outcomes, since the existence of logical meaning with the material (its relatability to cor respondingly relevant ideas that human beings *generally* can learn) is a prerequisite for its potential meaningfulness (its relatability to a *particular* learner's cognitive structure), and hence for the emergence of psychological (phenomenological) meaning Logical meaning, as previously pointed out, is a function of the plausibility, lucidity, and nonarbitrariness of the material rather than of its logical or substantive validity Hence, 'internal logic' is used somewhat idiosyncratically here to designate those properties of the material that enhance these latter criteria of logical meaning

In the absolute sense of the term, of course, for material to be logically meaningful it is only necessary that some human beings (the most intelligent and best prepared) be capable of learning it Obviously, however, there are also degrees of logical meaningfulness Depending on how appropriately ideas are expressed and organized, they can be related more or less readily to the cognitive structure of a particular individual who exhibits at least the minimally necessary degree of subject matter and developmental readiness In the relative sense of the term, therefore, it is legitimate to evaluate the internal logic of instructional materials from the standpoint of their appropriateness for learners at a specified level of intellectual ability and of subject matter and developmental readiness

At least eight aspects of the internal logic of instructional material presumably affect the extent to which it is endowed with logical meaning (a) adequacy of definition and diction (precise, consistent, and unambiguous use of terms, definition of all new terms prior to use, and the use of the simplest and least technical language that is compatible with conveying precise meanings), (b) the use of concrete empirical props and of relevant analogies when developmentally warranted or otherwise helpful in the acquisition, clarification, or dramatization of meanings, (c) stimulation of an active, critical, reflective, and analytic approach on the part of the learner, by encouraging him to reformulate presented ideas in terms of his own vocabulary, experiential background, and structure of ideas, (d) explicit conformity with the distinctive logic and philosophy of each subject matter discipline (its implicit epistemological assumptions, general problems of causality, categorization, inquiry, and measurement that are specific to the discipline) and with the distinctive strategy of learning how to learn the particular subject matter of the discipline, (e) the selection and organization of subject matter content around principles that have the widest and most general explanatory and integrative power, (f) systematic sequential organization of material with careful attention to gradation of difficulty level, (g) consistency with the principles of progressive differentiation and integrative reconciliation and (h) the use of appropriate organizers

Subject matter concepts are simply the generic meanings elicited by generic terms in a particular discipline In presenting subject matter concepts, therefore, it is important that programmers clearly understand their meanings in precise and sophisticated fashion Thus, it is desirable for the programmer to possess *both* subject matter and psychological (pedagogic) sophistication. Only the person who is sophisticated in both respects can exploit psychological techniques of effective presentation without overlooking or distorting the internal logic and organizational properties of the subject matter content itself

## Organization of Material

Throughout this volume it has been repeatedly stressed that the conditions of learning primarily influence the meaningful acquisition and retention of ideas and information by modifying existing cognitive structure Although the effect of such modification on learning and retention cannot be empirically demonstrated except by using the transfer paradigm (by measuring its effect on the learning and retention of related new tasks), the changes in cognitive structure wrought by practice or by exposure to successive aspects of the task obviously have an important impact on intra task mastery itself This is particularly true in the case of those kinds of learning in which each component task (as well as entire bodies of subject matter) tends to be compound in content and to manifest an internal organization of its own Thus, in school learning, conditions influencing and altering cognitive structure are typically crucial both for the acquisition of a particular task as well as for transfer purposes (the learning of related new tasks), and of all the possible conditions of learning that affect cognitive structure, it is self-evident that none can be more significant than organization of the material In previous chapters, we have already considered in great detail how learning material can be most effectively written and organized so as deliberately to induce those changes in cognitive structure that are most advantageous for the learning and retention of meaningful school material Hence, in the present context, it will be necessary only to summarize briefly the more salient of these considerations

### *Organizers versus Overviews*

The principles of progressive differentiation and integrative reconciliation have been represented throughout as being of central importance in the programming of meaningful subject matter Optimal utilization of these principles presupposes not only their consistent use in the sequential presentation of subject matter material, but also the supplementary availability of a hierarchical series of advance "organizers" These latter organizers provide relevant ideational scaffolding, enhance the discriminability of the new learning material from previously learned related ideas, and otherwise effect integrative reconciliation at a level of abstraction, generality, and inclusiveness which is much higher than that of the learning material itself To be maximally effective they must be formulated in terms of language and concepts already familiar to the learner, and use appropriate illustrations and analogies if developmentally necessary

True organizers, thus defined, should not be confused with ordinary introductory overviews The latter are typically written at the same level of abstraction, generality, and inclusiveness as the learning material, and achieve their effect largely through repetition, condensation, selective emphasis on central concepts and prefamiliarization of the learner with certain key words Summaries are comparable to overviews in construction, but are probably less effective because their influence on cognitive structure is retroactive rather than proactive relative to the learning task They are probably more useful, in place of the material itself, for purposes of rapid review than for original learning However, insofar as they may imply to some learners that the material they do *not* include is relatively superfluous, they may promote neglect of and failure to study or review much significant subject matter C W Lathrop and C A Norford (1949) found that neither overviews nor summaries appreciably improve the learning of instructional films

### *Organizers versus Intra material Organization*

Organizers also have certain inherent advantages both over various kinds of intra material organization (organizing aids within the body of the material), and over any existing subsumers within cognitive structure that could be used for organizational purposes Unlike intra material organization (executed in accordance with the principles of progressive differentiation and integrative reconciliation) that successively provides necessary anchorage for and differentiation of new ideas at a particularized level just before each new idea is encountered, organizers perform the same functions in advance at a much more global level before the learner is confronted with any of the new material Hence, for example, a generalized model of class relationships is first provided as a general subsumer for *all* new classes, subclasses, and species before more limited subsumers (classes or subclasses) are provided for the particular subclasses or species they encompass, and the various kinds of forests are first distinguished from each other before the component subforests and trees are similarly differentiated Spontaneously existing subsumers in cognitive structure, on the other hand, lack both particularized relevance for the new material (since the learner cannot possibly anticipate its precise nature) as well as the benefit of the sophisticated knowledge of subject matter and pedagogy available to expert programmers

### *Perceptual Organizers*

Perceptual organizers, in contrast to the integrative organizational devices just described merely provide built in mechanical aids that make the material perceptually more salient and apprehensible, or otherwise facilitate practice These include rhythmic aids, vocal emphasis, the isolation[6] and familiarization effects of underlining, and the fractionation effect (breaking of wholes into parts) of providing headings and subheadings Under certain circumstances however some perceptual organizers can be said to have true integrative effects (for instance, underlining that helps make ideational distinctions or emphasizes central concepts, headings that reveal the organizational structure of the material more clearly)

Perceptual or mechanical organizers generally facilitate meaningful learning—more so in the case of factual than of abstract material[7] The learning of meaningful material, for example is enhanced by appropriate vocal emphasis (Dearborn Johnson, and Carmichael, 1949), by underlining (Klare, Mabry and Gustafson, 1955), and by breaking instructional film content into parts by means of inserted questions (Kurtz, Walter, and Brenner 1950) Typographical highlighting of the more important material to be learned reduces the amount of learning of less important content but does not facilitate the learning of the more important core content (Hershberger 1964) The failure of informational learning to increase proportionately with increase in the density of facts in film (Vincent, Ash, and Greehill 1949) may be partly ascribed to the loss of the patterning or isolation effect as filler' material is removed

D S Northrop (1952) found that the use of headings facilitates the learning of factual films but either has no significant effect on or inhibits the learning of more abstract films The abstract material in this study was evidently more highly organized than the factual, simply because the abstract concepts themselves served as organizing function, hence, the

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[6] In several adequately controlled laboratory studies isolation effected by introducing patterned heterogeneity of content or color has been shown to facilitate rote learning of segregated and immediately adjacent items (Saul and Osgood 1950 Shay 1961 M H Smith and Stearns 1949) Retention however was not facilitated

[7] C M Christensen and K E Stordahl (1955) obtained uniformly negative results in studying the effects on comprehension and retention of various combinations of such organizational aids as underlining headings outlines and summaries However the possibility of obtaining significant differences between experimental and control groups was seriously prejudiced by the leveling effects of using familiar learning material using the same test as both a pretest and measure of retention and testing the same subjects for both immediate and delayed retention

learners not only benefited less from the presence of extrinsic mechanical organizers, but also seemed in some instances to be distracted by them Apparently integrative organizers are required for material that is more abstract than informational in character In none of the above studies, however, is it possible to distinguish clearly between the perceptual and the integrative effects of the organizers in question Conflicting results have also been reported regarding the relative effects of such organizers on bright and dull students

## *Organizers in Textual Material*

Generally speaking, therefore, it makes good organizational sense if the presentation of more detailed or specific information is preceded by a more general or inclusive principle to which it can be related or under which it can be subsumed This not only makes the new information more meaningful and enables the student to anchor more easily forgotten specifics to more easily remembered generalizations but also integrates related facts in terms of a common principle under which they can all be subsumed Thus, for example, in a physics, engineering, or biology course, the general characteristics of *all* regulatory or cybernetic systems should be presented before considering any *particular* regulatory or cybernetic system The latter, in turn, should be explicitly related to the more general principles, showing how they exemplify them This makes for some redundancy, but such redundancy, in turn, greatly reinforces the general principles Of course, the general principles themselves must be stated in terms and concepts that are already familiar to the learner Many teachers and textbooks are guilty of introducing complex and detailed information for which no adequate foundation has been laid in terms of organizing, unifying or explanatory principles

Thus a substantive introductory statement of the principal new ideas to be considered in the chapter, stated at a high level of generality and inclusiveness, to which the more detailed information in the chapter can be related could be very helpful in learning the latter information For example, a brief overview of the chief propositions underlying Darwin's theory of evolution would be of greater functional utility in learning the more detailed mechanisms through which evolution operates, or the different kinds of evidence for evolution, than the kinds of historical or anecdotal introductions provided in the three BSCS textbooks in introductory biology[8] (much folksy biographical information about Darwin

[8] By way of illustration in this section and in the remainder of the chapter the Biological Sciences Curriculum Study (BSCS) textbooks in introductory high school biology will be used to exemplify various points about instructional mate

or anecdotal material about how he arrived at his theory) The same applies to introductions that merely list the topics to be covered

It is not only desirable for the material in each chapter to become progressively more differentiated (to proceed from ideas of greater to lesser inclusiveness), but for textbooks as a whole (from one chapter to another) to follow the same organizational plan The *spiral* kind of organization, in which the same topics are treated at progressively higher levels of sophistication in successive sections is an extension of the same principle Textbook series in a given field that are intended for use at different instructional levels (elementary school high school undergraduate, and graduate) can also follow this organizational plan In this instance there is a progressive increase in scope depth complexity level of abstraction and level of sophistication at successively higher grade levels with the earlier acquired knowledge serving as a foundation for the more abstract and complex material introduced later In addition however some entirely new topics are introduced at the higher levels since many advanced topics are too complex and abstract to be taught successfully on an intuitive basis

In instances where new concepts are introduced that are similar or related to but not identical and hence confusable, with previously learned concepts (for instance instinct and imprinting fermentation and respiration spontaneous generation and performationism, elimination and excretion behavioral versus physiological or morphological adaptation, variation as both a cause and product of evolution), it is advisable to point out explicitly the similarities and differences between them and to make this connection in both contexts This practice integrates knowledge by making relationships between concepts explicit, by preventing artificial compartmentalization and the proliferation of separate terms for concepts that are basically the same except for contextual usage, and by differentiating between ostensibly similar but actually different concepts Ignoring such relationships between later appearing and previously learned content as-

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rials The three textbooks referred to are the yellow version (*Biological Science An Inquiry Into Life* (New York Harcourt Brace and World 1963) blue version (*Biological Science Molecules to Man* Boston Houghton Mifflin 1963) and green version (*High School Biology* Chicago Rand McNally and Company 1963) These comments were first published by the writer as an article An Evaluation of the BSCS Approach to High School Biology in *The American Biology Teacher*, 1966 *28* 176-186 The use of a curriculum reform project in only a *single* subject matter area—the one nonpsychological discipline (biology) in which the writer happens to have some substantive competence—for illustrating certain general principles regarding instructional materials is deliberate It conforms to the view defended later that educational psychologists are competent to evaluate and participate in a given curriculum reform project only if they are substantively sophisticated in the discipline in question sumes, rather unrealistically, that students will independently perform the *necessary cross referencing by themselves*

Organizers that are intended for elementary school pupils should be presented at a lower level of abstraction and should also make more extensive use of concrete empirical props They should take into account rather than ignore pre-existing organizing principles (preconceptions) in the learner s cognitive structure Often these preconceptions are based on widely accepted elements of cultural folklore that are very tenacious unless explicitly undermined

PERVASIVE THEMES Good organizational advantage can be taken of pervasive or recurrent themes that can integrate or interrelate many different topics or general ideas The green version of the BSCS, for example, uses the beginning chapters on the ' web of life ' as an integrative device *throughout the entire book None of the three versions, however, makes* adequate use of Darwinian theory as a pervasive organizing principle Evolutionary theory can be related to such varied concepts as uniformity and diversity in nature, genetic continuity, the complementarity of organism and environment, and of structure and function, the classification of and interrelationships between organisms, population genetics, the role of sexual reproduction in producing diversity, the geography of life, and the need for a self replicating mechanism as well as the biological significance of mistakes in self replication It is obviously necessary for pervasive themes to be introduced early in a book if they are to serve an integrative function But in the yellow and blue versions such themes (for example, regulatory mechanisms, homeostasis, the cybernetic principle, the relationship of theory to data) often do not appear until late in the game

In addition, the nine basic substantive themes of the three texts are not organically related to the actual content of the yellow and blue versions In the yellow version, after being listed formally in the first chapter, they are presumably forgotten and are no longer identifiable in the content itself The same is true of the blue version except that the themes are distributed quite randomly on separate pages scattered through the text In the green version, on the other hand, the themes emerge naturally *from* and *are* organically related to the content of each section

PRECONCEPTIONS AND THE INDIVIDUALIZATION OF INSTRUCTION The role of preconceptions in determining the longevity and qualitative content of what is learned and remembered is crucial, and may very well be the most important manipulable factor in the individualization of instruction This problem was alluded to above in discussing the need for *differential feedback* ( branching ' programs) and differential practice related to the kind of misconception exhibited by the pupil, and in rationalizing the need for early instruction in science to counteract pre existing folklore or idiosyncratic mis more common preconceptions of learners are by means of appropriate pretests and then to match suitably tailored organizers with pupils exhibiting corresponding preconceptions If I had to reduce all of educational psychology to just a single principle, I would say this "Find out what the learner already knows and teach him accordingly"

## 'Conceptual Schemes" Approach to Science Teaching

Paralleling the argument for a process' approach to science teaching, that is, teaching the heuristics of discovery' or 'scientific method' as ends in themselves—as the primary objectives of science instruction, in relation to which content is purely incidental and illustrative—is the notion that the same set of conceptual schemes can serve to integrate the substantive content of all of the scientific disciplines (N S T A Curriculum Committee, 1964) In our opinion, on philosophical grounds, no set of conceptual schemes or principles of scientific method is applicable to all sciences Each science has its own idiosyncratic undergirding themes and methods of inquiry An all encompassing set of conceptual themes is apt to be characterized (a) by a level of generality that is reminiscent of the philosophy of science, and hence beyond the cognitive maturity and scientific sophistication of elementary and high school students, and (b) by far fetched relevance and applicability to many scientific disciplines The seven conceptual schemes prepared by the NSTA Curriculum Committee are characterized by both of these features They are both stated at a high level of generality, and are applicable to the physical sciences but not very applicable to biology, psychology, and the social sciences But, even if an epistemologically tenable set of principles comprehensive enough to embrace *all* sciences with equal aptness and relevance could be formulated, its very utility (its transferability to the separate sciences its ability to serve as superordinate subsumers for the less general themes characterizing any single discipline) would obviously be dependent on its being understood and applied at the high level of generality implicit in any such formulation On developmental grounds, however, elementary school pupils could, at the very most, hope to understand these themes at an intuitive (semi abstract, semi general) level if at all, and high school and undergraduate students would typically lack sufficient sophistication in a wide enough variety of sciences genuinely to understand principles at this philosophical level of generalization about science

The solution to this problem of curriculum development in science lies not in abandoning the conceptual schemes approach This would be throwing away the baby with the bath water The conceptual schemes approach is philosophically, psychologically, and pedagogically sound, pro-conceptions Unfortunately however very little research has been conducted on this crucial problem despite the fact that the unlearning of preconceptions might very well prove to be the most determinative single factor in the acquisition and retention of subject matter knowledge

In any case anyone who has attempted to teach science to children or to adults for that matter is painfully aware of the potent role of preconceptions in inhibiting the learning and retention of scientific concepts and principles These preconceptions are amazingly tenacious and resistant to extinction because of the influence of such factors as primacy and frequency, because they are typically anchored to highly stable related and antecedent preconceptions of a more inclusive nature because they are inherently more stable (for example more general less qualified expressive of a positive rather than inverse relationship predicated on single rather than multiple causality or on dichotomous rather than continuous variability) and lastly, because resistance to the acceptance of new ideas contrary to prevailing beliefs seems to be characteristic of human learning Some of the reasons for individual differences in the tenacity of preconceptions probably include those that are related to cognitive style to such personality traits as closed mindedness and to self-consistent individual differences in generalized aspects of reductionism in cognitive functioning

General findings regarding the role of cognitive organizers would appear to have significant implications for those aspects of individualization of instruction that are related to the problem of preconceptions It seems plausible to suppose that if advance organizers can be used in nonindividualized fashion generally to bridge the gap between what learners already know and what they have to learn at any given moment in their educational careers then individualized organizers specially tailored to the particular preconceptions of a particular learner will have an even more facilitating effect on meaningful learning and retention Unless proposed organizers take explicit account of and attempt explicitly to extinguish, existing preconceptions it seems likely that these preconceptions will both inhibit related new learning of more valid scientific concepts and principles and eventually assimilate through memorial reduction, the proposed new ideas designed to replace them A very common preconception for example, among elementary school children is that the outer integument constitutes a kind of sack filled with blood prick it at any point and it bleeds Actually this is not an implausible hypothesis Is it conceivable therefore that one can effectively instruct such children about the circulatory system without taking into account and trying to undermine the relative credibility and explanatory value of this preconception as compared with that of a closed system of vessels?

Thus a seemingly important precondition for constructing individualized organizers for instructional units in science is to ascertain what the more common preconceptions of learners are by means of appropriate pretests and then to match suitably tailored organizers with pupils exhibiting corresponding preconceptions. If I had to reduce all of educational psychology to just a single principle I would say this Find out what the learner already knows and teach him accordingly

### "Conceptual Schemes" Approach to Science Teaching

Paralleling the argument for a process approach to science teaching that is teaching the heuristics of discovery or scientific method as ends in themselves—as the primary objectives of science instruction in relation to which content is purely incidental and illustrative—is the notion that the same set of conceptual schemes can serve to integrate the substantive content of all of the scientific disciplines (NSTA Curriculum Committee 1964) In our opinion on philosophical grounds no set of conceptual schemes or principles of scientific method is applicable to all sciences. Each science has its own idiosyncratic undergirding themes and methods of inquiry An all encompassing set of conceptual themes is apt to be characterized (a) by a level of generality that is reminiscent of the philosophy of science and hence beyond the cognitive maturity and scientific sophistication of elementary and high school students and (b) by far fetched relevance and applicability to many scientific disciplines The seven conceptual schemes prepared by the NSTA Curriculum Committee are characterized by both of these features. They are both stated at a high level of generality and are applicable to the physical sciences but not very applicable to biology psychology and the social sciences. But, even if an epistemologically tenable set of principles comprehensive enough to embrace *all* sciences with equal aptness and relevance could be formulated its very utility (its transferability to the separate sciences its ability to serve as superordinate subsumers for the less general themes characterizing any single discipline) would obviously be dependent on its being understood and applied at the high level of generality implicit in any such formulation On developmental grounds however elementary school pupils could at the very most hope to understand these themes at an intuitive (semi abstract semi general) level if at all and high school and undergraduate students would typically lack sufficient sophistication in a wide enough variety of sciences genuinely to understand principles at this philosophical level of generalization about science.

The solution to this problem of curriculum development *in science* lies not in abandoning the conceptual schemes approach This would be throwing away the baby with the bath water The conceptual schemes approach is philosophically psychologically and pedagogically sound provided that it is modified so that a separate set of conceptual schemes is made available for each particular discipline However, to seek one set of conceptual schemes that attempts to encompass all science is as illusory as seeking the fountain of youth or the philosopher s stone

## Effective Communication

Effective communication in the classroom that is appropriate translation from the highly sophisticated cognitive structure of the teacher or textbook writer—in terms of cognitive maturity and subject matter knowledge—to the less highly sophisticated cognitive structure of the student is a complex and delicate art Certain important elements of communication style have already been considered as part of the internal logic of the material Sufficient redundancy is necessary both for purposes of ordinary comprehension and retention (Cantril and Allport, 1935) and to take account of unfamiliarity of ideas and occasional wandering of attention, such redundancy however should take the form of paraphrase example, analogy, and application to other problems rather than of sheer repetition An effort should be made to arouse interest and to achieve lucidity and incisiveness of expression One topic should lead naturally and obviously into another Tangential asides and digressions should be avoided Long quotations from original or archaic sources generally serve no useful purpose

The writing style should be as simple as in consistent with precise expression but not so simple as to give the impression of talking down to students (as is the case in most textbooks in education) Teachers and writers should remember that no amount of linguistic simplification can make inherently complex ideas easy to grasp and whereas initial simplification is always pedagogically defensible, misleading oversimplification is worse than no simplification at all Since a new subject is most difficult in the beginning, it should be presented most simply at first, with level of difficulty increasing progressively as the student s level of sophistication increases To maintain effective communication some type of frequent feedback is necessary This may take the form of quizzes Socratic questioning class discussion, and questions from students

Seldom does a textbook appear containing any new or unfamiliar ideas that is not immediately condemned out of hand as being unnecessarily difficult to read and understand simply because it requires teachers or reviewers to reorganize their thinking about the familiar content of their field Hence, even though the introduction of explanatory and integrative ideas actually makes the subject matter easier for students to understand and remember than a collection of discrete unrelated and often contradictory facts the teacher and reviewer, who resent the effort of grappling with new ideas and a challenging level of discourse, rationalize their resentment by attacking not the ideas themselves but the way in which they are expressed It is then easy enough to demonstrate that such a book—because it contains abstract unifying ideas—is less readable" than the theoretically bland compendium of unintegrated and unexplained facts to which they are accustomed, and is thus presumably unsuitable for typical students

Examples and illustrations should be intended to clarify and not to serve as superfluous padding or to generate a spurious aura of scientific authenticity If they are permitted to become excessively detailed, complex, or esoteric, they tend to become ends in themselves, thereby obscuring rather than clarifying the ideas they exemplify For example, structural diagrams of nucleic acid, DNA, and chlorophyll molecules are meaningless to chemically unsophisticated students in an introductory biology course It should be borne in mind that intellectually mature students (those who are adolescent or older) do not require examples routinely but only for atypically difficult or unfamiliar ideas Beyond the elementary school period, examples are necessary sometimes for purposes of occasional illustration or clarification of difficult abstractions, they should not be used in an attempt to reduce such ideas to an intuitive level

In presenting instructional material, it is almost always advantageous to proceed from the familiar to the unfamiliar, using previously acquired knowledge and experience both as a foundation for understanding, interpreting, and remembering related new material that is less familiar, and as a means of rendering the latter less threatening Thus, in elementary biology it is advisable to consider mammals before simpler animals, and flowering plants before simple plants Order of presentation should not be determined on the basis of level of biological organization ( from molecule to man ) or level of phyletic complexity The phyletic principle of organization may conform to some abstract cannon of scientific logic, but it violates everything we know about the psychology of learning, and runs counter to the intuitive judgment of anyone who has ever done any classroom teaching In ascertaining what is more or less familiar, or more or less difficult, psychological principles of learning and of intellectual development are more relevant and reliable guidelines than the wholly gratuitous assumption that level of phenomenological complexity in science necessarily parallels level of learning difficulty

### *Level of Sophistication*

In the yellow and blue BSCS versions, it appears as if little effort was made to discriminate between basic and highly sophisticated content—between what is appropriate and essential of an introductory high school course and what could be more profitably reserved for more advanced courses These versions include topics, detail, and level of sophistication that vary in appropriateness from the tenth grade to graduate school [9] Only the green version gives the impression of being at an appropriate level of sophistication for a beginning course And since the unsophisticated student cannot be expected to distinguish between more and less important material, he either throws up his hands in despair, learns nothing thoroughly in the effort to learn everything or relies on rote memorization and cramming' to get through examinations

The blue version, especially, appears sufficiently sophisticated and challenging to constitute an introductory college course for students who already have an introductory biology course in high school as well as courses in chemistry and physics It is true, of course, that subjects once thought too difficult for high school students (for example set theory, analytical geometry, and calculus) *can* be taught successfully to *bright* high school students with good quantitative *ability* *But* in the latter instances, students are adequately prepared for these advanced subjects by virtue of taking the necessary preliminary, and sequentially antecedent courses in mathematics The blue version on the other hand, presents biological material of college-level difficulty and sophistication to students who do not have the necessary background in chemistry, physics and elementary biology for learning it meaningfully It should also be remembered that college level mathematics is not considered appropriate for *all* high school students, but only for those brighter students with better than average aptitude in mathematics who are college bound and intend to major in such fields as mathematics, science, engineering and architecture

An introductory high school course in any discipline should concentrate more on establishing a general ideational framework than in putting a great deal of flesh on the skeleton Generally speaking, only the framework is retained anyway after a considerable retention interval, and if more time is spent on overlearning the framework, plus a minimum of detail, than in superficially learning a large mass of oversophisticated and poorly understood material, both more of the important ideas are retained in the case of students taking the subject terminally, and a better foundation is laid for students who intend to take more advanced courses later

Oversophisticated detail is not only unnecessary and inappropriate for a beginning course but also hinders learning and generates unfavorable attitudes toward the subject The student can t see the forest for the trees'

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[9] Much of the inappropriately high level of sophistication of the BSCS text books is undoubtedly a deliberate overreaction to the outdated content, paucity of explanatory ideas, the completely descriptive approach, and the kindergarten writing style and level of difficulty characterizing most textbooks in introductory high school biology

The main conceptual themes get lost or become unidentifiable in a welter of detail Both the average student and the student not particularly interested in science would tend to feel overwhelmed by the vast quantity and complexity of detail, terminology, methodology, and historical material in the blue and yellow versions And a student who feels overwhelmed by a subject tends to develop an aversion toward it, and to resort to rote memorization for examination purposes

It is not necessary for a beginning student to be given so much sequential historical detail about the development of biological ideas, related experimental evidence from original sources, and pedantic information about all of the various misconceptions and twistings and turnings taken by these ideas before they evolve into their currently accepted form As a result, the ideas themselves—which are really the important things to be learned—tend to be obscured and rendered less salient This practice also places an unnecessary and unwarranted burden on learning and memory effort—effort that could be more profitably expended on learning the ideas themselves and the more significant aspects of their historical development

To give students the flavor of biology as an evolving empirical science with a complex and often circuitous history, it would suffice to cite several examples It is unnecessary to give the detailed ideational and experimental history of every biological concept and controversy Unsophisticated students also tend to be confused by raw experimental data, and by the actual chronological and experimental history underlying the emergence of a biological law or theory—especially when long quotations are given from original sources that use archaic language, refer to obscure controversies, and report findings and inferences in an unfamiliar and discursive manner It is sufficient (as the green version does) to review the historical background of biological concepts in a schematic, telescoped, simplified, and reconstructed fashion, deleting most of the detail, and disregarding the actual chronological order of the antecedent ideas and their related experiments

### *Theoretical Bias*

Introductory textbooks should generally be free of strong theoretical bias and axe grinding They should give the impression that all theoretical issues are not yet finally resolved, that many different points of view are still theoretically tenable, and that the final word still has not been (and never will be) spoken This does not mean, of course, that it is wrong or undesirable for a textbook writer to express a point of view or theoretical bias As long as he explicitly acknowledges his bias and fairly presents current alternative positions, the adoption of an unambiguous point of view has the advantage of theoretical consistency over blander and more eclectic approaches Philosophical indoctrination, however, is indefensible when students are too unsophisticated to evaluate the merits of a given theoretical orientation Until they are sufficiently mature to form independent judgments, it is important that they be permitted to retain an open mind on controversial issues in the philosophy of science

The green version is more disposed than the blue and yellow versions to concede that very little is known about some topics, that some concepts are based on relatively little solid evidence, that the same evidence is subject to different interpretations, and the contemporary biologists do not always agree with each other It also stresses, more than the other versions do, that biological knowledge is not immutable, and that it changes both as new facts and techniques are discovered and as new theories are proposed Finally, the green version suggests more explicitly than the other versions do that biological concepts and classifications are man made attempts to interpret, organize, and simplify our understanding of natural phenomena; and that such concepts and categories are neither coextensive with the data from which they are derived, nor represent the only ways of conceptualizing and categorizing the same data. This distinction between an abstraction and empirical reality is important for beginning students, who frequently tend to think of concepts and categories in absolute and axiomatic terms, as if given in reality itself and possessing the same reality status as data

## Instructional Aids[10]

With the growth of our psychological and pedagogic knowledge about, and technological capacity for, presenting instructional materials efficiently to learners at each stage of cognitive and subject matter sophistication, the role of instructional aids in education is gradually changing No longer do these aids serve merely enrichment or evaluative functions in transmitting subject matter content to students, but do, and largely should, carry the routine burden of such transmission Thus, ideally, after the primary grades, curriculum materials should be produced for students rather than for teachers When the content of a curriculum program is appropriately prepared and pre tested for learnability and lucidity, and contains adjunctive feedback devices, there is little value in using the teacher as a filter through which the content of subject matter reaches pupils (Novak, 1965). Perhaps 0 1 percent of teachers can present subject matter as lucidly and efficiently

[10] This term is used in the generic sense and includes all media which the teacher uses for instructional purposes apart from oral communication—textbooks, workbooks, schematic models and diagrams, demonstrations, laboratory work, motion pictures, television, teaching machines.

as properly programmed materials and the use of programmed material does *not* necessarily imply teaching machine programs or scrambled text books that granulate material into such small segments that its logical structure and interrelationships are no longer perceptible[11]

When programmed subject matter material is transmitted to pupils directly it not only reaches them more clearly and effectively but can also be delivered on an individualized self paceable basis thereby circumventing the ideational and pedagogic limitations of nine hundred and ninety nine teachers in a thousand The teacher s role is not eliminated but is channeled more into the stimulation of interest the planning and direction of learning activities the provision of more complete and individualized feedback in instances that are idiosyncratic to particular learners the evaluation of achievement the guidance of independent study thinking and problem solving and the direction of discussion about issues that are too controversial or speculative to be programmed efficiently The teacher is far too valuable a person to spend his time giving routine lectures about relatively stable and fixed areas of knowledge (Ericksen 1967) Typically programmed materials would consist of texts that are written by teams of subject matter and learning theory specialists in accordance with established psychological principles of presentation and organization that are empirically pretested and suitably revised to guarantee the maximal lucidity of each idea that either present adjunctive tests of genuine understanding plus appropriate feedback after each self contained subsection and/or call upon the teacher to do so that make provisions for consolidation (confirmation correction and differential practice) before new material is presented and that provide for adequate review after progressively increasing intervals of time

For the most part instructional aids have contributed very little thus far to the goal of individualized instruction

> Elementary schools high schools and colleges throughout the country are engaging in a variety of programs to improve instruction More often than not however these modifications and innovations do not come to grips in a direct and systematic way with the primary event—the acquisition of knowledge by the individual student One basic goal for educational change must be to recognize the individual student rather than the class as the functional unit in the instructional process The widely publicized claims that teaching machines and programmed

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[11] Unless otherwise noted programmed textbook in this volume does *not* refer to the typical scrambled textbook currently on the market but rather to conventional format textbooks that are written in accordance with the instructional strategy advocated in this and preceding chapters Such books are typically supplemented by the adjunctive type of automated instruction advocated by S L Pressey (1960 1962a 1962b) for purposes of feedback and evaluation

instruction have established the educational breakthrough for adapting to individual differences is a gross overstatement Adapting to the *rate* of learning is only one dimension and any tutor live or automated must be able to respond to the other differences that mark the idiosyncratic learning progress of each student (Ericksen 1967, p 176)

Other significant dimensions of individualization include size of step, difficulty and level of abstraction of material, degree of prior preparation and familiarization, and the provision of enriched content

## *Printed Materials*

For the routine transmission of subject matter content, printed materials are undoubtedly the method of choice Not only can a much greater quantity of material be presented in a given unit of time, but rate of presentation is also under the control of the learner Thus, the latter can pace himself in accordance with his intelligence reading skill, and subject matter sophistication He can also take as much time as he wishes to savor the language, to reflect on the material, and to relate it to other relevant ideas The objective of increasing speed of reading to the point that precludes these latter activities is educationally unsound Contrary to general belief among teachers and students, N E James (1962) found that the use of a preferred method of learning meaningful material (for instance, reading versus lecture) makes no difference whatsoever in learning outcomes

The deficiencies frequently ascribed to textbooks are not really inherent in the medium itself but reflect, rather, deficiencies that are common to all inadequately prepared instructional materials such as lack of lucidity, ineffective communication, inappropriate level of sophistication, and absence of explanatory and integrative ideas Relatively few textbooks have ever been written which take into account considerations such as progressive differentiation, integrative reconciliation, sequentiality of subject matter content, and use of organizers. Although textbooks can contain some built in adjunctive feedback and evaluative devices, and can, to a limited extent, stimulate and guide the student s independent study, thinking, and problem solving activities, further provisions along these lines must be made by the teacher The latter is also responsible for such matters as differential practice, review, recitation, and prompting, and for coordinating the textbook with lectures discussion laboratory work, other audiovisual aids supplementary reading and independent student projects (such as essays, reports) It should be remembered that beyond the junior high school period concrete-empirical props should not ordinarily be used to foster an *intuitive* type of meaningful learning—except in the early stages of introducing students to an unfamiliar new discipline At other times, their function is to facilitate and clarify the *abstract* learning of concepts and propositions

### *Laboratory*

The laboratory as a medium of instruction implies more than *direct* contact with and observation of objects and events As differentiated from demonstration and observational exercise, it also involves discovery experience and concern with such aspects of the process of science as hypothesis formation and testing, designing and conducting experiments, controlling and manipulating variables, and making inferences from data Thus, in science education one can hardly disagree with the proposition that

> a heavy emphasis should be placed on the nature of science or the *process* by which new knowledge is obtained Instruction should be planned to develop understanding of the basic ideas of science concomitant with the appreciation of the methods of science these two aspects should not be treated independently (NSTA Curriculum Committee 1964 pp 17 18)

The trouble with this statement, in our opinion, is that it is not sufficiently explicit It emphasizes the role of the laboratory in teaching the process of science and the importance of coordinating laboratory and expository instruction, they certainly should not be treated independently But primary responsibility for transmitting the content of science should be delegated to teacher and textbook, whereas primary responsibility for transmitting appreciation of scientific method should be delegated to the laboratory This does not imply that laboratory and classroom should not be coordinated, or that related substantive and methodological principles should not be considered together whenever relevant

Yet science courses at all academic levels are traditionally organized so that students waste many valuable hours in the laboratory collecting and manipulating empirical data which, at the very best, help them rediscover or exemplify principles that the instructor could present verbally and demonstrate visually in a matter of minutes Hence, although laboratory work can easily be justified on the grounds of giving students some appreciation of the spirit and methods of scientific inquiry and of promoting problem solving analytic, and generalizing ability, it is a very time-consuming and inefficient practice for routine purposes of teaching subject matter content or illustrating principles where didactic exposition or simple demonstration are perfectly adequate Knowledge of the methods whereby data and principles in a particular discipline are acquired also need not be gained always through self discovery in the laboratory In many instances, this purpose can be accomplished much more efficiently through didactic exposition in conjunction with demonstrations and exercises

Laboratory work in this context refers to inductive or hypothetico deductive discovery experience and should not be confused with demonstrations and simple exercises Nevertheless it involves a contrived type of discovery that is very different from the truly autonomous discovery activities of the research scholar and scientist The immature or unsophisticated student is only confused by the natural complexities of raw unselected and unsystematized data Before he can discover generalizations efficiently the problem must be structured for him and the available procedures and methods of handling data must be skilfully arranged by others that is simplified selectively schematized and sequentially organized in such a way as to make ultimate discovery almost inevitable Occasional independent design of experiments may have a salutary effect in conveying the actual spirit of scientific inquiry but should hardly be a routine procedure

Most students below the graduate level of instruction lack both sufficient sophistication in science and sufficient ingenuity and originality autonomously to devise all of the experiments that are necessary for learning the process of science and even if they could the procedure would be much too time consuming to warrant the modest advantages in understanding and appreciating scientific method that such an approach would confer over arranged laboratory work It is no more necessary autonomously to discover methods of discovering scientific knowledge in order genuinely to understand and appreciate the process of science than it is necessary autonomously to discover the products of scientific investigation in order meaningfully to learn scientific concepts and principles

In short personal laboratory experience is both useful and necessary for the understanding of science but truly independent laboratory research in the schools is useful only occasionally (rather than as a routine practice) to give students the flavor of autonomous scientific inquiry The latter kind of experience in other words can hardly be equated with individualized laboratory work Individualization of instruction in the laboratory conforms to the same principles of individualized instruction in expository teaching that were discussed above and does not necessarily or typically presuppose independent design of experiments or wholly autonomous discovery learning

Thus in dividing the labor of scientific instruction the laboratory typically carries the burden of conveying the method and spirit of science whereas the textbook and teacher assume the burden of transmitting subject matter content The laboratory however should be carefully integrated with the textbook that is it should deal with methodology related to the subject matter of the course and not with experiments chosen solely because of their suitability for illustrating various strategies of discovery It goes without saying of course that laboratory methods can be used only where the underlying methodology and substantive principles are thoroughly

### *Programmed Instruction*

In the generic sense of the term programmed instruction is an individualized form of self instruction in which emphasis is placed on sequentiality, lucidity, and graded difficulty in the presentation of learning tasks, on confirmatory and corrective feedback and on consolidation and subject matter readiness An attempt is made in programmed instruction to manipulate as optimally as possible all practice, task and transfer variables that are relevant for the acquisition and retention of subject matter content In preceding sections and chapters we have reviewed much research on these variables in a programmed instruction context, on the general effectiveness of this approach, and on presumptive reasons for its effectiveness Only a brief summary statement, therefore, is necessary at this point

Our conclusion with regard to programmed instruction has been that it is potentially the most effective method for transmitting the established content of most subject matter fields Although programmed instruction can include some guided discovery and vicarious concrete-empirical experience, it is obviously less effective than laboratory and demonstration for learning scientific method and for acquiring observational and discrimination skills It is also less suitable than discussion and project methods for considering more controversial aspects of subject matter for expressing originality and independence of thought, and for learning how to adopt and defend a debatable position As pointed out above the most efficient form of programmed instruction can be effected within a conventional textbook format, providing the material has been pretested for sequentiality and lucidity, contains adequate provision for the testing of knowledge and for feedback, and takes into account established substantive and programmatic principles of facilitating the acquisition and retention of subject matter content

The weight of the evidence regarding the effectiveness of programmed instruction indicates that it leads to learning outcomes that are either equally as good as or slightly better than those of conventional methods (Glaser, 1965 Hughes and McNamara, 1961, Poppleton and Austwick, 1964 Schramm 1964, Whitlock, Copeland, and Craig, 1963) Most students tend to react favorably to the programmed learning format (Eigen, 1963), at least in the beginning, loss of enthusiasm sets in earlier at the university level (Roth, 1963) than in elementary school (Porter, 1959) This latter finding suggests that some of its demonstrated effectiveness may be attributable either to novelty or to the Hawthorne effect

It cannot be stressed too strongly that most of the available evidence about this mode of instruction is *not* derived from programmed instruction in the generic sense defined above, but rather from research on 'teaching machines' and scrambled textbooks that employ a relatively small frame and small step size approach Various other special features of the Skinnerian linear programming technique such as emphasis on overt, constructed responses on a low error rate (on invariably inducing success and avoiding uncertainty), and on the direct reinforcing effect of rewarding every correct response, have already been shown to be either empirically unsupportable or theoretically untenable

Whatever effectiveness automated instruction has been found to possess can be attributed to such factors as consolidation, lucidity, individualization, prompting and confirmatory and corrective feedback The important pro gramming principle of sequentiality has not really been tested yet on a long term basis, since most programs (at least insofar as sub units within a given learning task are concerned) do not presuppose a logical sequence of items such that each sub unit is sequentially dependent on the preceding intra task sub unit, it apparently makes little difference whether the frames are carefully sequenced or presented in random order (N R Hamilton, 1964, Levin and Baker, 1963, Roe, Case, and Roe, 1962) Also, apart from several short term studies, the effects of both substantive aspects of programming and of such programmatic principles as progressive differentiation, integrative reconciliation, the use of organizers, spaced review, and attention to the internal logic of the instructional material, have not been investigated S L Pressey s (1962a, 1962b) adjunctive use of self scoring devices makes possible only those beneficial effects on learning that follow from evaluation and feedback, and does not deal with the optimal organization and presenta tion of subject matter

## Curriculum Reform Movements

The Biological Sciences Curriculum Study may be taken as typical in approach and objectives to the many flourishing curriculum reform movements that have arisen in the past fifteen years Its principal objective is to re establish the close contact and congruence of high school biology with current conceptual and methodological developments in biological science, while still maintaining, and even increasing, its congruence with current psychological and pedagogic ideas about the learning teaching process as they apply to tenth grade students (Schwab, 1963) According to J J Schwab, the content of high school biology, during the heyday of progressive educa tion, was no longer mainly determined by the state of knowledge in the scientific field,' because of its excessive preoccupation with such matters as intellectual readiness, the learnability of material, and individual differences among learners The BSCS approach, however, has veered precisely toward the opposite extreme in trying to correct this unsatisfactory state of affairs, its three texts are reasonably congruent with the content and methods of modern biology but except for the green version are psychologically and pedagogically unsound for the majority of tenth graders

Actually of course there is no inherent incompatibility between subject matter soundness on the one hand and pedagogic effectiveness on the other It is no more necessary to produce pedagogically inappropriate instructional materials in an attempt to make them reflective of the current state of knowledge in a given discipline than it is necessary to present discredited concepts or inaccurate facts in order to make the subject matter more learnable In practice however as the yellow and blue BSCS versions demonstrate preoccupation with the recency of subject matter content and with the completeness of conceptual methodological and historical coverage can easily lead to the neglect of such basic pedagogic considerations as the educational appropriateness of course approach and objectives the adequacy of the pupils existing academic background for learning the content of the course and the psychological tenability of the chosen ways of presenting organizing and sequencing materials The inevitable outcome under these circumstances is the production of instructional materials that are admirably thorough accurate and up-to date but so ineffectively presented and organized and so impossibly sophisticated for their intended audience as to be intrinsically unlearnable on a long term basis

Although the BSCS does not state explicitly its specific dissatisfactions with conventional high school biology textbooks these dissatisfactions can be readily inferred from the content of its numerous publications and are generally illustrative of the perceived need for curriculum reform in the sciences (1) Conventional texts abound in outmoded ideas and incorrect information and ignore important contemporary developments in the biological sciences (2) They are written at a largely descriptive level and contain relatively few explanatory concepts too much stress is placed on structural detail useless terminological distinctions and classification thereby placing a premium on rote memory (3) Their approach is too naturalistic and insufficiently experimental quantitative and analytical (4) They tend to focus excessively on the organ and tissue levels of biological organization whereas recent biological progress has been greatest at the molecular (biophysical and biochemical) cellular population and community levels (5) They are written at too low a level of sophistication and contain a profusion of elementary and self-evident generalizations (6) Insufficient emphasis is placed on biology as a form of inquiry as an experimental science and as an ever changing open ended discipline (7) the biological ideas they contain are not presented in terms of their historical development and are not related to the social and technological contexts from which they arise (8) They lack organizing and unifying themes present a mass of disconnected facts and fail to integrate related concepts and different levels of biological organization. (9) They place excessive em... tion of biology to such areas as medicine pub... conservation, and insufficient emphasis on basic biological ... in themselves.

### *Specification of Objectives in Behavioral Terms*

For many years now, evaluation specialists have been exhorting curriculum workers "State your objectives in behavioral terms so that their realization can be subjected more easily to objective evaluation" As Atkin (1963) points out however, such exhortation often does more harm than good In the first place both psychologists and subject matter specialists may give more attention to relatively trivial but readily definable goals than to goals that are intrinsically more important but resistive to precise behavioral definition Second, few curriculum specialists are trained to define goals in behavioral language Most important however is the fact that behavioral terminology more often obscures than clarifies educational goals The taxonomy of educational objectives (Bloom Engelhart Furst Hill and Krathwohl 1956 Krathwohl and others 1964) for example categorizes educational goals in great behavioral detail But since such basic terms as memory knowledge understanding transfer meaning cognitive and affective have very different meanings for psychologists and educators of different theoretical persuasion classification of curriculum objectives along such lines merely results in considerable pseudo agreement among psychologists and curriculum workers without ever really defining what the actual objectives in question are

A taxonomy of educational objectives in behavioral terms can of course be potentially very useful both for curriculum planning and evaluation and for designing functional and differential measures of educational outcomes once the discipline of educational psychology itself attains a certain minimal degree of sophistication and stability However until there is more genuine understanding of and general agreement about the underlying processes of and interrelationship among the important kinds of classroom learning outcomes its use for these purposes is somewhat comparable to employing a micrometer to measure inches feet and yards Taxonomic distinctions at the species level are somewhat premature and misleading when distinctions between the major phyla are still generally unsettled In the present state of our knowledge in educational psychology it is probably more realistic and generally satisfactory to define educational objectives in grosser and more descriptive terms that are closer to the language of the curriculum worker than to that of the psychologist

### *Collaboration of Subject Matter, Learning Theory, and Measurement Specialists*

A basic premise of all curriculum reform projects is that only a person with subject matter competence[12] in a given discipline should prepare curriculum materials in that discipline Only such a person is sufficiently sophisticated (a) to identify unifying and integrative concepts with broad generalizability and explanatory power in the field (b) to perceive the interrelationships between different ideas and topics so as to organize, sequence, and integrate them optimally, (c) to comprehend the process of inquiry and the relationship of theory to data in the discipline in order to select appropriate laboratory exercises and to integrate process and content aspects of the curriculum program and (d) to understand the subject matter content well enough either to prepare textual materials lucidly himself, or to judge whether others have done so

To be pedagogically effective such curriculum materials also have to conform to established principles in the psychology of classroom learning, and must include evaluative devices that conform to established principles of evaluation and measurement Obviously, it is difficult for any one person to possess all three competencies But a *pure* educational psychologist or measurement specialist cannot really collaborate with a subject matter specialist in producing curriculum materials and measuring instruments—apart from communicating to him general principles of learning theory and measurement

This type of help however is inadequate for the actual collaborative task that needs to be done In the actual operation of producing curriculum and evaluative materials that are sound on both subject matter and learning theory measurement grounds the educational psychologist and measurement specialist can collaborate effectively with their colleagues in subject matter fields only if they themselves are sufficiently sophisticated in the subject matter to participate actively in the production of the curriculum materials from the very start Only in this way can they ensure that the detailed content and structure of the material conform to established principles of learning and measurement theory One possible solution to this problem of producing sound instructional materials is to train a new type of curriculum worker either a subject matter specialist who is sophisticated (but not expert) in learning theory or measurement to collaborate with learning theory and measurement specialists or a learning theory or measurement specialist

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[12] In actual practice three different kinds of persons provide different kinds of subject matter as well as pedagogic, competence in projects such as the BSCS a professional biologist, a specialist in the teaching of biology and a classroom biology teacher

who is sophisticated (but not expert) in some subject matter field, to collaborate with subject matter specialists

### *Single-Unit versus Integrated Curriculum Approach*

Generally speaking it is not pedagogically tenable to produce science curriculum materials apart from an integrated plan encompassing each of *the separate scientific disciplines at successively higher levels of difficulty* from elementary school through college A collection of supplementary grade appropriate units in various scientific disciplines, even when used in conjunction with existing curriculum materials, presents many dfficulties (a) It does not further the construction of a sequentially organized curriculum in any particular discipline at any grade level that is logically coherent and systematic in its component topics (b) Students fail to develop a conception of each scientific discipline as a sequentially organized, logically integrated, and coherently interrelated body of knowledge (c) For a given discipline to be organized for optimal learning on a longitudinal basis, one must plan in advance for the articulation of the various levels of difficulty so that some topics are considered at progressively higher levels of sophistication whereas other topics are introduced for the first time when specified levels of subject matter sophistication and cognitive maturity are reached

This kind of large scale, integrated curriculum planning requires no greater certainty in the minds of the specialists on exactly how science materials should be scheduled to guarantee learning' than does the production of small unintegrated units of material The same principles are involved but on a much more massive scale One starts with the same tentative outline based on logical interrelationships between the component aspects of a discipline, as modified by pertinent developmental and learning theory considerations, prepares tentative units, and revises these units on the basis of try out experience or alters their grade placement level If this is done by a team, say twenty times larger than the one ordinarily envisaged, it can prepare an integrated science curriculum in the same length of time that it takes an average sized team to prepare an unintegrated series of units Admittedly, this involves *many more administrative problems, but if one* adheres to the principle of immediate try out of component units, there should not necessarily be any problem of 'rigidity The deficiencies in the existing large scale, integrated projects stem more from (a) untenable theoretical ideas about teaching and learning (for instance, overemphasis on the importance of discovery in learning, overemphasis on the 'basic science,' experimental analytic approach), (b) uncoordinated team effort, resulting in the production of textbooks consisting of unintegrated units, and no pervasive organizing ideas that are organically related to the textual material (for example, blue and yellow BSCS versions), (c) *failure to try out the*

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### *"Basic" versus "Applied" Science Approach*

The strong emphasis in the yellow and blue BSCS versions on 'basic science' principles, and their relative lack of concern with applications to familiar or practical problems, is in accord with current fashionable trends in science education Current curriculum projects have tended to overemphasize the basic sciences (because of their great generalizing power and relative timelessness), and unwarrantedly to denigrate the role and importance of applied science in general education If the aim of the science curriculum is to acquaint the student with the goals and limitations of the scientific enterprise, and to help him understand, as an end in itself, the conceptual meaning of the current phenomenological world that confronts him, it cannot afford to overlook the applied sciences They constitute a significant aspect of modern man's phenomenological and intellectual environment, and hence an important component of general education Knowledge about such subjects as medicine, agronomy, and engineering should be taught *not* to make professional physicians, agronomists and engineers out of all students, or to help them solve everyday problems in these areas, but to make them more literate and intellectually sophisticated about the current world in which they live

The time bound and particular properties of knowledge in the applied sciences have also been exaggerated Such knowledge involves more than technological applications of basic science generalizations to current practical problems Although less generalizable than the basic sciences, they are also disciplines in their own right, with distinctive and relatively enduring bodies of theory and methodology that cannot simply be derived or extrapolated from the basic sciences to which they are related. It is simply not true that only basic science knowledge can be *related to and organized* around general principles Each of the applied biological sciences (for example, medicine, agronomy) possesses an independent body of general principles underlying the detailed knowledge in its field, in addition to being related in a still more general way to basic principles in biology

Applied sciences also present us with many strategic advantages in teaching and curriculum development. We can capitalize on the student s existing interest in and familiarity with applied problems in science to provide an intellectual and motivational bridge for learning the content of the basic sciences Previously acquired knowledge in the applied sciences, both incidental and systematic, can serve as the basis for rendering basic science concepts and propositions both potentially meaningful to the learner and less threatening to him There is also good reason for believing that applied sciences are intrinsically more learnable than basic sciences to the elementary school child, because of the particularized and intuitive nature of his cognitive processes and their dependence on the "here and now" properties of concrete empirical experience For example, before the tenth grader ever enters the biology class, he has a vast fund of information about immunization, chemotherapy, the symptoms of infection, heredity, and so forth Finally, knowledge in the applied sciences probably is retained longer than knowledge in the basic sciences because of the greater frequency of their subsequent use (by virtue of more frequent applicability to intellectual experience in adult life)

### *Overemphasis on Analytical, Quantitative, and Experimental Aspects of Science*

One of the characteristic features of the curriculum reform movement is an overcorrection of the unnecessarily low level of sophistication at which many high school subjects have been and still are taught In the sciences this tendency is marked by a virtual repudiation of the descriptive, naturalistic, and applied approach and an overemphasis on the analytical, experimental, and quantitative aspects of science In introductory high school biology, for example, much of the new content consists of highly sophisticated biochemical content that presupposes advanced knowledge of chemistry on the part of students who have no background whatsoever in this subject The implied rationale of this policy is Bruner's untenable assertion that any concept can be taught to any person irrespective of his level of subject matter sophistication

By any reasonable pedagogic criterion, introductory high school biology should continue to remain predominantly naturalistic and descriptive in approach rather than analytical and experimental This does not imply emphasis on descriptive information or on disconnected facts unrelated to theory, but on explanatory concepts that are stated in relatively gross and descriptive language, instead of in the more technical, quantitative, and sophisticated terminology of biochemistry and biophysics In short, high school biology should concentrate on those broad biological ideas that constitute part of general education—physiology, evolution, development, inheritance, uniformities and diversity in life, ecology, and man's place in nature—rather than on a detailed and technical analysis of the physical and chemical basis of biological phenomena or of the morphology and function of intracellular microstructures This is particularly true for the substantial number of students who will receive no further instruction in biology As a matter of fact, there is still much significant but as yet unex plotted conceptual content in introductory biology that can be treated in much more sophisticated terms at a descriptive level without having to resort to the depth of biochemical and cellular detail given in the yellow and blue BSCS versions

Contrary to the strong and explicitly stated bias of the blue and yellow versions there is still much room in introductory biology for the naturalistic approach It is much more important for the beginning student in science to learn how to observe events in nature systematically and precisely and how to formulate and test hypotheses on the basis of independent sets of naturally occurring antecedents and consequences than to learn how to manipulate an experimental variable and control other relevant variables by design in a laboratory situation The former approach not only takes precedence in the student s intellectual development and is more consonant with his experiential background but also has more transfer value for problem solving in future real life contexts To dogmatically equate scientific method with the experimental analytical approach also excludes rather summarily from the domain of science such fields in biology as ecology paleontology and evolution and such other disciplines as geology astronomy meteorology anthropology and sociology

This bias against the naturalistic approach has already reached the point where pupils are being taught that cause-and-effect and explanatory relationships between independent and dependent variables can be warrantedly inferred only if the independent variables under investigation can be reliably manipulated and if other relevant variables can be adequately controlled. This pseudo-scientific dictum ignores both statistical methods of control and the more important fact that controlled experiments in nature occur spontaneously every day in the week, inviting the student of science merely to formulate and test relevant hypotheses without any need whatsoever for experimental manipulation and control.

Retention of the naturalistic and descriptive emphasis and of some applied content, in introductory high school biology is thus consistent with the fact that tenth-grade biology is the terminal course in science for many students. It is also more consistent than is the analytical-experimental approach with the tenth-grader s existing background of experience his interests his intellectual readiness and his relative degree of sophistication in science This proposed emphasis is also in no way inappropriate for those students who will subsequently take high school physics and chemistry as well as more advanced biology courses These latter students would be much better prepared after taking such an introductory course for a second course in biology in the twelfth grade or in college that takes a more quantitative and experimental analytical approach introduces more esoteric topics and considers the biochemical and biophysical aspects of biological knowledge By this time they would also have the necessary mathematical sophistication and greater experience with experimental methodology

### *Early Try Out of Materials*

An essential aspect of the preparation of instructional materials that is unfortunately, ignored much too frequently by many curriculum reform projects is the matter of early and continuous try-out both with individual pupils and in classrooms Only in this way is it possible to ascertain their appropriateness and effectiveness, and to modify the original logically de veloped outline in terms of empirically relevant information regarding learnability lucidity, difficulty level, sequence, organization, practicality, and attitudes of pupils, teachers, and administrators All too often huge sums of money are invested in preparing an integrated series of curriculum materials without making any provision for try-out and evaluation until the finished product is published

### *Overemphasis on Discovery and Inquiry*

Most curriculum reform projects in mathematics and science place inordinate emphasis on the inquiry process and on learning by discovery Implicit in this approach are the assumptions that subverbal insight is superior to verbal insight, that generalizations are not really understood unless they are discovered autonomously, and that the student can learn best by engaging in the same kinds of activities as mathematicians and scientists These assumptions are subjected to detailed scrutiny in Chapter 14 Their principal weakness lies in failure to recognize the time-consuming aspects of discovery learning and to appreciate the respective roles of ex pository teaching and discovery experience in acquiring subject matter con tent, on the one hand, and in learning problem solving skills and the scientific method, on the other

### *Difficulties in Evaluating the New Curriculums*

As W A Brownell (1965) points out, curriculum evaluation is more difficult than it often appears on the surface This in large part, is a func tion of the fact that standardized achievement tests both cover various traditional subject matter units deliberately ignored by the new curric ulums, as well as fail to measure knowledge of the more modern concepts which the latter emphasize Further, many curriculum projects either make no provisions whatsoever for evaluation or fail to provide for an adequate control group and to eliminate the Hawthorne effect The weight of the evidence indicates that on the basis of achievement test results, the new curriculums in mathematics and science are approximately as effective as existing curriculums If this were our ultimate criterion of effectiveness, however, these findings would be quite disappointing Much more impor ploited conceptual content in introductory biology that can be treated in much more sophisticated terms at a descriptive level, without having to resort to the depth of biochemical and cellular detail given in the yellow and blue BSCS versions

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### *The Leveling Effect of Instructional Aids on Degree of Existing Knowledge*

It seems reasonable to suppose that in a nonindividualized learning environment organizational aids and other improved methods of teaching tend to benefit the average and dull student more than the bright student, that is, to exert a leveling influence on the relationship between degree of existing knowledge and aptitude, on the one hand, and new learning in the same subject matter area, on the other The bright student, after all, could be expected to structure and organize unfamiliar learning materials more successfully by himself The research evidence in this area, however, tends to be equivocal The lucid integrative teaching in the PSSC high school physics program not only brings it well within the ability of most high school physics students (Ferris, 1960), but also tends to produce progressively decreasing correlations between academic aptitude and physics achievement as the course progresses Brighter students are evidently able to do for them selves part of what improved methods of teaching do for mediocre students Conventional methods of teaching, on the other hand, tend to maintain and perpetuate the existing learning and achievement advantages inherent in superior verbal ability When students are thrown back on their own devices, the superior student has a better chance of learning Both D Porter (1959) and M H Detambel and L M Stolurow (1956) obtained almost zero correlations between general ability measures and achievement on programmed learning tasks and L W Joos (1961) showed that automated teaching programs in arithmetic differentially benefit low IQ children

D S Northrop (1952) similarly found that whatever increased learning results from emphasizing the outline of an instructional film comes primarily from the low ability group The use of organizers is suggestively more bene ficial for low ability students in the learning of completely unfamiliar material (Ausubel and Fitzgerald, 1962), but is unrelated to academic aptitude when the learning material is substantively related to existing knowledge (Ausubel and Fitzgerald, 1961) The dull individual is more apt to profit from advance organizers than the bright individual, because he is both less likely to possess and choose existing relevant subsumers in his cognitive structure for the new material, and is also less able to improvise appropriate new organizers by himself

Teaching machine programs that gear the difficulty of the material to the ability level of the lowest ability group quite naturally tend to reduce the relationship between general ability and ultimate learning outcomes

In addition to lowering difficulty level by such devices as prompting and the use of small task and step size (L M Smith, 1962), such programs benefit *the slow learner more than the fast learner by compensating for the former's* relatively greater inability both to organize the material sequentially by himself and to keep pace with a rate of instruction aimed at the pupil of average ability L M Stolurow (1961b, pp 121, 126, 136 138) has summarized considerable research evidence showing increased homogeneity of performance following teaching machine training, as well as practically zero correlations between general ability scores and gain scores resulting from automated instruction S R Meyer (1960a) obtained a moderate negative correlation between pretest scores on knowledge of English prefixes and gain in such knowledge after ten days of self instruction with a programmed workbook Programmed instruction in electrocardiography differentially benefits academically poorer students (Owen, and others, 1965) J K Little (1960) similarly found that drill machines giving immediate knowledge of results of practice tests in an educational psychology course, as well as opportunity to correct mistakes by drill, benefits those students most who usually score in the lower half of the distribution As a result of such teaching, both the more and the less knowledgeable students move upwards in attainment, but the terminal achievement of the two groups converges

E R Keislar (1959), *on the other hand, found that programmed instruction* in elementary arithmetic was more successful for brighter pupils G R Klare and others (1955) showed that patterning, in the form of outlining, inhibited learning in the low ability group but facilitated learning in the upper ability group

When teaching machine programs are more demanding, low ability students make lower scores than high ability students on tests covering material completed by each group (Beane, 1962, Keislar and McNeil, 1961, Shay, 1961, Silberman, Melaragno, and Coulson, 1961, Wittrock, 1963c), and if the abler students are also permitted to learn at their own pace and to complete as many programs as rapidly as they can, individual differences in achievement between the bright and the dull obviously tend to increase rather than to decrease during the course of sequentially organized instruction (Beberman, 1958) This phenomenon apparently reflects both the increased learning opportunities given the more able pupils, as well as the reciprocal circular relationship between relative success and failure, on the one hand, and interest and motivation, on the other Despite this divergence, however, dull pupils who are permitted to learn at their own rate of speed obviously acquire a sounder foundation of knowledge, and also maintain higher educational morale than when forced to proceed and flounder at a rate exceeding their ability level

# AFFECTIVE AND SOCIAL FACTORS IN LEARNING

Chapter 10

# MOTIVATIONAL FACTORS IN LEARNING[1]

AFTER FIFTY YEARS OR MORE OF RESEARCH on motivation perhaps the most striking conclusion that emerges from consideration of the staggering mass of research data and theory in this area is how little we really know about it and how much is still a matter of conjecture and speculative preference Fortunately however since the focus of our concern is on the role of motivation in learning particularly on long term meaningful reception learning we shall not have to grapple with such general issues as the nature and classification of drives Only the following kinds of issues need engage our attention Is motivation necessary for learning? How do motivational variables differ from cognitive variables? What are the respective roles of intrinsic and extrinsic motivation in subject matter learning and how do they change with the age of the learner? In what ways does reward (the satisfaction of drives) influence learning and retention? Can meaningful learning be reinforced? How do intention ego-involvement and attitude influence learning? Are punishment and aversive drives effective in motivating learning?

One of the theoretical biases that should be made explicit at the very outset is the assumption that both the role and relative importance of different kinds of motivations (for example cognitive homeostatic material ego-enhancing aversive and affiliative) vary depending on the type of learning involved and on the species membership and developmental status of the learner Hence it could be anticipated that the role and relative importance of these various kinds of motivations in classroom learning would be quite different than in short term and fragmentary varieties of rote instrumental motor and discovery learning

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1 Some of the material in this chapter has been excerpted with permission from an article Motivation and Classroom Management by the author in *Education* 1966 *86* 479-483 Copyright 1966 by The Bobbs-Merrill Company Inc. Indianapolis Indiana

## Is Motivation Necessary for Learning?

Few theoretical issues in psychology provoke more heated controversy than the role of motivation in learning Positions vary all the way from the assertion that no learning whatsoever takes place without motivation to a complete denial that motivation is a significant variable in the learning process The weight of the evidence indicates that although motivation is a highly significant factor in and greatly facilitates learning it is by no means an indispensable condition[2] Considerable research suggests that much learning is apparently neither energized by motivation nor reinforced by drive satisfaction (reduction) Classical or Pavlovian conditioning for example, merely depends on temporal contiguity of the conditioned and unconditioned stimuli A good deal of learning as pointed out above, occurs incidentally without any explicit intention to learn Appreciation of a means-end relationship is frequently acquired and selectively retained, either through insight or trial and error variation of responses, even if unaccompanied by the original existence and later reduction of a drive state

Apart from classical conditioning however, motivation is probably less indispensable for meaningful reception learning (particularly on an unorganized short term basis) than it is for any other kind of learning Because such learning requires relatively little effort, less reliance need be placed on existing drives and motives within the learner, on incentive conditions, and on extrinsic rewards than is the case, for example, in rote learning or problem solving But to assert that meaningful learning (particularly of a fragmentary and short term nature) can occur in the absence of motivation, does not of course, imply denial of the fact that motivation can significantly facilitate learning whenever it is present and operative

Even where motivation is clearly operative in human learning, it is misleading to extrapolate the familiar paradigm of homeostatic drive reduction that is characteristically used to explain animal learning (Harlow, 1953) Such drives are quickly satiated and, when accompanied by intense effect disrupt learning (Harlow, 1953) Hence, hunger, thirst, pain, and the like, rarely motivate human learning and although material rewards are

[2] On theoretical grounds it may be hypothesized that motivation becomes a progressively less important factor in learning as children advance in age As learning becomes easier and less effortful due to the growth of cognitive capacity attention span and ability to concentrate, less energization of the learning process is necessary In addition cognitive structure variables become increasingly more important as determinants of learning Lastly since the child is motivated more by cognitive affiliative and ego-enhancement drives material reward and punishment become less salient factors

often effective intrinsic (task oriented) and ego enhancing motives increasingly tend to dominate the motivational picture with advancing age Material rewards also tend to become less ends in themselves than symbols of earned or attributed status and sources of self esteem

The trend in recent research and thinking has been to place greater emphasis on the motivational power of such intrinsic and positive motives as curiosity (Berlyne, 1960), exploration (Montgomery, 1954), activity (W F Hill, 1956), manipulation (Harlow, 1950, Terrell, 1959), mastery or competence (White, 1959) and the need for stimulation (Butler, 1954) In addition, these latter drives have been elevated to the status of primary drives in their own right Unlike other drives, they are, furthermore, gratified (reduced) merely by the very fact of successful learning itself It is hardly surprising, therefore, that in many human learning situations the provision of explicit rewards makes relatively little (Abel, 1936) or no (Auble and Mech, 1953) difference in speed of learning or in performance level Because so much learning attributable to task-oriented or ego enhancing motives has already occurred, the later introduction of homeostatic or material rewards into the learning situation does not dramatically accelerate the rate of learning as it does in comparable animal ( latent learning") experiments

At the human level, cognitive drive (the desire for knowledge as an end in itself) is more important in meaningful than in rote or instrumental learning, and is, at least potentially, the most important kind of motivation in classroom learning This is so, both because of its inherent potency, and because meaningful learning unlike these other kinds of human learning, automatically provides its own reward That is, as in the case of all intrinsic motives, the reward that satisfies the drive inheres in the task itself In addition, as E C Tolman (1932) points out, motivation may facilitate learning in ways other than by energizing behavior and by reinforcing the successful variant through drive reduction It also exerts a purely cognitive effect by highlighting or emphasizing what is to be learned, and by providing confirmatory and corrective feedback This is evident both in meaningful discovery learning and in meaningful reception learning where the choice of correct alternatives is rewarded and the choice of incorrect alternatives is not

The causal relationship between motivation and learning is typically reciprocal rather than unidirectional Both for this reason, and because motivation is not an indispensable condition of learning, it is unnecessary to postpone learning activities until appropriate interests and motivations have been developed Frequently, the best way of teaching an unmotivated student is to ignore his motivational state for the time being, and to concentrate on teaching him as effectively as possible Some degree of learning will ensue in any case, despite the lack of motivation, and from the initial satisfaction of learning he will, hopefully, develop the motivation to learn more In some circumstances, therefore, the most appropriate way of arousing motivation to learn is to focus on the cognitive rather than on the motivational aspects of learning and to rely on the motivation that is developed from successful educational achievement to energize further learning

Even though *particular* instances of learning may be largely unmotivated, it is undoubtedly true that the subject matter in question must be related to felt needs if significant *long term* meaningful learning is to occur Inability to see any need for a subject is the reason students mention most frequently for losing interest in high school studies (F M Young 1932) Doing without being interested in what one is doing, results in relatively little permanent learning (Cantor, 1953) since it is reasonable to suppose that only subject matter material which is relevant to areas of concern in the psychological field of the individual can be meaningfully and efficiently incorporated and integrated into cognitive structure on a long term basis Learners who have little need to know and understand quite naturally expend relatively little learning effort, manifest an insufficiently meaningful learning set, fail to develop precise meanings to reconcile new material with existing concepts, and to reformulate new propositions in their own terms and do not devote enough time and effort to practice and review Knowledge is, therefore never sufficiently consolidated to form an adequate foundation for sequential learning Hence it is unrealistic to expect that school subjects can be effectively learned and retained until pupils develop a felt need to acquire knowledge as an end in itself—since much school knowledge can never be rationalized as necessary for meeting the demands of daily living Once such a need is developed learning naturally becomes both a more meaningful and a more satisfying experience, but it is difficult to stimulate the development of such needs until subject matter is presented meaningfully in the first place

Since meaningfulness is largely a personal phenomenon, it can be achieved only if the individual is willing to expend the *active* effort required to integrate new conceptual material into his unique frame of reference This means translating and rephrasing new ideas into his own terms and relating them to his own experience, personal history, and system of ideas (H D Carter, 1935)

If learning is to be active, greater responsibility for its accomplishment must lie with the pupil Pupils, not teachers, need to ask more of the questions and to be more concerned with formulating perceived problems than with learning answers to questions where problems are not perceived (Cantor, 1953) The teacher cannot learn for the pupil nor navigate intellectually for him. He can only present ideas as meaningfully as possible. The actual job of articulating new ideas into a personal frame of reference can only be performed by the learner It follows that ideas that are forcibly imposed upon pupils or passively and uncritically accepted by them cannot possibly be meaningful in the true sense of the term

## Cognitive Drive

Because meaningful learning provides its own reward, cognitive drive (the desire to know and understand, to master knowledge, to formulate and solve problems) is more important than in rote or instrumental learning, and is potentially the most important kind of motivation in meaningful learning It is probably derived, in a very general way, from curiosity tendencies and from related predispositions to explore, manipulate,[3] understand, and cope with the environment (R W White, 1959) These latter predispositions, however, originally manifest potential rather than actual motivational properties, and are obviously nonspecific in content and direction Their potential motivating power is actualized in expression and particularized in direction by the developing individual, both as a result of successful exercise and the anticipation of future satisfying consequences from further exercise, and as a result of internalization of the values of those significant persons in the familial and cultural environments with whom he identifies Far from being largely endogenous[4] in origin, therefore, specific cognitive drives or interests are primarily acquired and dependent upon particular experience Hence, we observe again that the relationship between cognitive drive and learning, like the relationship between motivation and learning generally, is reciprocal from a cause-effect standpoint

Despite the potential centrality of cognitive drive for classroom learn

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[3] The desire to explore, manipulate, and be stimulated does not, in and of itself, lead to disciplined learning effort In its untutored expression it is directed more toward immediate gratification

[4] We have already referred to the mistaken notion in some educational circles of regarding endogenous or spontaneously expressed needs as the only possible basis on which to organize a curriculum and as axiomatically reflective of what is truly best ' for the individual The choices that individuals make themselves are not invariably as appropriate as teleological theorists would have us believe In fact one of the primary functions of education is to stimulate the development of potentially worthwhile needs Recognition of the role of needs in learning means that teachers should try to develop needs in pupils for the subject matter they wish to present as well as take cognizance of existing concerns It does not mean that the curriculum should be restricted to the specific interests that happen to be present in a group of children growing up under particular conditions of intellectual and social class stimulation

ing, it is nevertheless true that in our utilitarian, competitive, and achievement-oriented culture, such extrinsic considerations as ego-enhancement, anxiety reduction, and career advancement become, with increasing age, progressively more significant sources of motivation for school learning Beginning with the first four years of school life, ratings of achievement and recognition seeking behavior tend to remain quite stable, and are reasonably predictive of analogous behavior during adolescence and early adult life (Moss and Kagan, 1961) Even material rewards tend to become less ends in themselves than symbols of academic status achievement, and competitive advantage

Eventually of course, the viability of the cognitive drive as an intrinsic, task-oriented type of motivation is impaired as a consequence of the increasing, almost exclusive, association of intellectual interests and activities *with ego-enhancing and* anxiety reduction motives If the desire to learn and understand is almost invariably exercised in the context of competing for grades obtaining degrees, preparing for a vocation, striving for advancement, and reducing the fear of academic and occupational failure, there is little warrant for believing that much of it survives as a goal in its own right. This trend is reflected in the progressive decline in school interests and intellectual enthusiasm as children move up the academic ladder (Jersild and Tasch, 1949) Theoretically, of course, it is true that some cognitive drive may be developed as a functionally autonomous by product of successful learning, even though the intellectual activity in question is originally motivated by extrinsic considerations

Hence if we wish to develop the cognitive drive so that it remains viable during the school years and in adult life, it is necessary to move still further away from the educational doctrine of gearing the curriculum to the current concerns and life adjustment problems of pupils Although it is undoubtedly unrealistic and even undesirable in our culture to eschew entirely the utilitarian ego-enhancement, and anxiety reduction motivations for learning, we must place increasingly greater emphasis upon the value of knowing and understanding as goals in their own right, quite apart *from any practical benefits they may confer* Instead of denigrating subject matter knowledge, as so many allegedly progressive educators have done over the past fifty years, we must discover more efficient methods of fostering the long term acquisition of meaningful and usable bodies of knowledge, and of developing appropriate intrinsic motivations for such learning

## The Mediation of Motivational Influences

How do motivational factors actually influence meaningful learning and retention, and how does this influence differ from that of the cognitive variables we have considered in previous chapters? In the first place, *cognitive variables influence directly the very conditions (parameters) determining the interaction between new learning material and existing cognitive structure,* and hence the emergence of new meanings and the maintenance of their separate identity and availability during the retention interval (their dissociability strength) Such variables, for example, include the availability in cognitive structure of relevant anchoring ideas, the stability and clarity of such ideas, and their discriminability from the learning material, additional opportunity to relate the new learning material to a cognitive structure already sensitized to its meaning by virtue of prior exposure (spaced review), the confirmation and correction of newly acquired meanings through recitation, implicit testing against original or subsequent presentations of the material, or explicit testing with feedback, opportunity to profit during review from awareness of specific factors promoting forgetting, and the amount, difficulty, pacing, and internal logic of the instructional material

Second, *the effects of cognitive variables are also mediated through the same mechanisms in both learning and retention* That is, these variables determine the accuracy, clarity, and discriminability of emerging new meanings during learning (their dissociability strength) by influencing the cognitive interactional process in the particular aforementioned ways, and this same influence of cognitive variables on dissociability strength both (a) can be exerted during retention as well as during learning and (b) continues to operate cumulatively during the retention interval, thereby determining the relative degree of availability of the newly learned meanings

Typically, however, *motivational and attitudinal variables are not directly involved in the cognitive interactional process* They energize and expedite this process during learning by enhancing effort, attention, and immediate readiness for learning and thus facilitate dissociability strength catalytically and nonspecifically (rather than through direct involvement in the parameters of the interactional process) Furthermore, *the effects of motivational variables on learning and retention, respectively, unlike their cognitive counterparts, are not mediated through the same mechanisms* After learning is completed, these variables cannot independently affect dissociability strength (that is, apart from their effects on learning itself), and therefore can only influence retention during the reproductive phase of memory by elevating thresholds of availability and by shaping the qualitative aspects of imaginative reconstruction

Thus motivational and attitudinal factors affect meaningful learning and retention in ways that are qualitatively different from the comparable effects of relevant cognitive variables These latter variables (the availability of relevant anchoring ideas and their relative stability and clarity) directly and specifically influence the parameters of the cognitive interactional process underlying meaningful reception learning and retention, and are thus organically involved in the determination of dissociability strength Motivational and attitudinal variables, on the other hand, are not organically involved in the cognitive interactional process or in the determination of dissociability strength For the most part they merely impinge indirectly on this process and influence dissociability strength in a nonspecific facilitating fashion For example, through such motivational effects as mobilization of effort and concentration of attention, more repetitions of the material can be completed within the stipulated learning time, and each repetition is conducted more efficiently The net result is an indirect, nonspecific, overall increase in dissociability strength for the learning process so energized

It is also reasonable to assume that the effects of cognitive variables on meaningful learning continue along similar lines during retention and are mediated by the same mechanisms Whatever these effects on the interactional process are they are simply extended temporally from learning to retention Thus, the rate at which dissociability strength declines during retention reflects the continuing influence of these same cognitive variables on the interactional process during the retention interval However, once the learning sessions have been completed and the cognitive interactional products have been formed, a channel of communication no longer remains open for the energizing and expediting aspects of motivation to influence dissociability strength even in a catalytic or nonspecific sense Hence, if motivational factors are to affect retention independently of learning, a new mechanism is required to mediate this influence, a mechanism that becomes operative not during the retention interval, but during the reproductive stage of memory

*Learning*

During meaningful reception learning motivational and attitudinal variables may energize all or selected aspects of the learning field They impinge catalytically and nonspecifically on the cognitive interactional process, by enhancing effort attention, and immediate readiness, without affecting any of its basic parameters (for instance, the availability of relevant appropriate subsumers, the latter's stability, clarity, and discriminability from the learning task) Hence, they neither determine any of its qualitative attributes nor differentially influence dissociability strength apart from a nonspecific facilitating effect on learning[5] Illustrative of the energizing effect

[5] Apparent exceptions to this generalization include the effects of meaningful learning set, integrative drive self critical attitudes and cognitive style which influence the emergence, precision integrativeness, and other qualitative aspects of

of motivation on learning is the fact that subjects who have high needs for achievement are more persistent (Feather, 1961), learn more effectively (Kight and Sassenrath, 1966) and tend to reach solutions in problem solving tasks more often than do subjects with low achievement needs (French and Thomas 1958) Persistence in task performance is also related to strength of cognitive drive (Kohn 1965) and to the relative incentive value of the task (Nakamura and Boroczi, 1965) On a long term basis, high achievement motivation tends to be associated with greater academic achievement (Krug, 1959 Uhlinger and Stephens 1960) Measures of such motivation, when used in conjunction with measures of academic aptitude, are excellent pre dictors of college performance (Weiss, Wertheimer, and Groesbeck, 1959)

Much of the facilitating effect of motivation on learning is mediated by an increase in attention [6] Merely directing students attention to certain aspects of subject matter, irrespective of how this is done, promotes learning (Entwisle, 1961) Academically achieving male college students are less susceptible to distraction than their underachieving peers (Baker and Madell, 1965)

Many properties of the learning situation that foster cognitive drive facilitate learning by attracting and sustaining attention These include novelty, incongruity, surprise, change, and conceptual conflict (Berlyne, 1960) A moderate amount of discrepancy, incongruity or gap between existing knowledge and a new learning task is most effective in mobilizing attention particularly when the learner is dissatisfied with what he knows In J Piaget s terms, a child is most attentive to new learning tasks when they require some degree of accommodation on his part before they can be assimilated—when existing schemas are not wholly adequate for under standing or problem solving and require some but not too much modi fication On this basis alone, it could be anticipated that the diminutive step-size approach of teaching machines would not be optimally effective for meaningful learning

In addition to its energizing effects on meaningful reception learning

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meanings But despite the terms used these factors must by definition be con sidered cognitive or at most quasi motivational variables They impinge directly on the dissociability strength of new meanings but their influence unlike that of true cognitive variables is not carried over into the retention interval

[6] Attention, of course also depends on factors other than motivation (for instance relevant experience and training) One of the principal reasons why culturally deprived children fail to learn is that they have not been adequately trained at home in paying attention (M Deutsch 1963) In part however, their low attention span is reflective of insufficiently developed intrinsic and extrinsic motivation to learn

(by enhancing effort, attention, and persistence), motivation also mobilizes nonspecifically the individual's immediate readiness for such learning by lowering the thresholds of those general kinds of perceptions and responses that are customarily implicated in the learning process Exemplifying this latter mechanism is the lowering of reaction times that occurs in response to instructions to work faster (Owens, 1959) (as opposed to task oriented instructions or instructions to relax) It is important, however, not to confuse this nonspecific motivational facilitation with the more direct and specific influence on dissociability strength that is exerted by such variables as meaningful learning set integrative drive, and self critical attitudes As a result of the operation of these latter, more specific quasi motivational mechanisms during learning, clearer and more stable meanings are acquired and retained, which in turn facilitate the sequential type of learning involved in the mastery of subject matter For example, both L Festinger (1958) and D E Berlyne (1960) speak of the need to reduce dissonance, incongruity, or conflict betwen two cognitions This may lead to change in one of the beliefs to integrative reconciliation, or, as pointed out above to summary dismissal or compartmentalization of the contradictory cognition

An optimal level of motivation or ego involvement (neither too high nor too low) apparently exists for complex kinds of learning (Iverson and Reuter, 1956) According to J S Bruner (1957), impelling drive states may conceivably disrupt meaningful generic learning both by overemphasizing the particularity of newly learned concepts, and by limiting the learner's ability to apply previously learned principles to newly learned tasks, and hence to go appropriately beyond the information given' In support of this proposition he cites an experiment conducted by L Postman and himself in which subjects under stress made less improvement than a nonstress group in lowering their perceptual thresholds while learning to recognize tachistoscopically presented three word sentences Stated in terms of an hypothesized physiological basis of motivation, a moderate amount of activation or arousal seems to have an optimal effect on learning (Malmo 1959)

### *Retention*

Once the learning sessions have been completed and the cognitive interactional products have been formed, a channel of influence no longer remains open for the energizing and expediting aspects of motivation to affect dissociability strength even in a catalytic or nonspecific sense [7] At this

[7] As will be pointed out below in the discussion of selective retention of those controversial materials toward which learners have a positive as opposed to a negative attitudinal bias, positive ego-involvement (in this instance, positive atti

point therefore it is more parsimonious to postulate that motivational and attitudinal variables continue to affect retention outcomes that is indepen dently of their prior effects on learning only insofar as they impinge on the *reproductive* aspects of memory

Both theoretical considerations and the weight of the available evidence suggest that motivational factors influence *meaningful* retention selectively by inhibiting (raising) rather than facilitating (lowering) particular thresh olds of recognition and recall[8] Positive ego involvement and favorable attitudinal bias in other words do not increase retention by lowering thresholds of memorial elicitation but rather strong motivation to forget and certain kinds of attitudinal bias (for example in ego-threatening or anxiety producing situations) may selectively promote forgetting by raising thresholds of availability (repression) Thus unlike the situation in learn ing not only is the selective influence of motivational variables on mean ingful retention inhibitory rather than facilitating (catalytic) but the influence of these variables is also mediated solely through a change in thresholds of memorial elicitation without any change whatsoever in dis- sociability strength itself Although the latter remains constant recall or recognition is nevertheless rendered momentarily more difficult because of the selective elevation of particular thresholds of availability[9]

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tudinal bias) *can* facilitate retention by increasing dissociability strength However th s is not a genuine motivational effect on retention but is attributable to *cogni tive* or nonaffective components of attitude structure which in the case of positive attitudinal bias tend to provide a highly clear and stable set of subsuming concepts for the learning and retention of the controvers al material

[8] There is suggestive evidence that thresholds of availability of *rotely* (but not meaningfully) learned items can be lowered after learning (a) Motivational and affective factors (ego-involvement ego enhancement considerations a need to remember and so forth) have been shown to enhance rotely learned memories See Ausubel (1963a p 231) for a summary of relevant studies (b) Drive states such as hunger both generally lower all response thresholds and selectively lower the thresholds of el citation of simple responses (for instance sucking) and perceptions that are particularly relevant for satisfying the underlying needs (Ausubel 1958 p 207) The fact that th s selectivity is manifested at birth implies that the thresh olds of el citation of these relevant responses are differentially sensitive on an un learned basis to the general threshold lowering effects of drive states It is con ceivable therefore that when this same relevance is acquired on the basis of prior successful learning experience the affectively satisfying effects of drive reduc tion selectively sensitize the thresholds of elicitation of the drive reducing responses to the later general threshold lowering effects of the drive The only comparable evidence for meaningful learning outcomes suggest that affective and motivational states (for instance anxiety) raise but do not lower thresholds of availability

[9] As previously indicated motivational and attitudinal factors not only help determine by raising thresholds of availability whether or not material of near

It appears likely, therefore, that motivational factors influence retention—by raising thresholds of availability—only in those relatively rare instances where retrieval of particular information would be ego-threatening or productive of anxiety as for example, in the repression of memories that would, if recalled, give rise to feelings of guilt or self disparagement These kinds of forgetting however, would not occur very frequently in typical classroom learning situations

How, then, would one explain the more common facilitating effect of positive attitudinal bias on retention? Why, for example would a Democrat tend to remember more pro-New Deal material than a Republican? The most parsimonious explanation is not that pro-New Deal sentiments lower and anti New Deal sentiments raise thresholds of availability, but rather that attitudes have a cognitive as well as an affective component. That is, along with his pro-New Deal sentiments a New Dealer tends to possess a stable set of abstract and inclusive propositions reflective of New Deal ideology that more easily enable him to learn and retain differentiated information and evaluative implications favorable to New Deal ideology

Although the primary and direct effect of motivational variables on meaningful retention, when they are operative, is to elevate thresholds of availability (or to make the memories in question less available in relation to their intrinsic dissociability strength) it is theoretically conceivable that motivation (a strong incentive to recall) could also indirectly lower thresholds of availability It would do this by counteracting or disinhibiting certain inhibitory factors (distraction inattention, inertia, disinclination toward effort) that temporarily raise such thresholds We have already observed how various inhibitory conditions such as initial learning shock and the competition of alternative memories tend to dissipate spontaneously, and how hypnosis can reduce the inhibitory effect both of competing memories and of motives and attitudes promoting repression, as for example, in the case of anxiety producing material It still has to be empirically determined whether strong motivation or positive ego-involvement could similarly facilitate retention by disinhibiting temporarily elevated thresholds of availability

Finally, as F C Bartlett (1932) points out, motivational variables are probably also involved in the reconstructive aspects of the reproductive phase of memory—in making a selection from among the available remembered items and in organizing them into a coherent verbal response to meet the demands of a current situation Strictly speaking, however, the framing of a response in which memories are reported is not part of the retention process

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## Ego-Enhancement and Affiliative Components of Achievement Motivation

What is generally regarded as achievement motivation in school settings is by no means the reflection of a unitary or homogeneous drive It has at least three components One of these which we have already encountered is cognitive drive—the need for acquiring knowledge and solving academic problems as ends in themselves This drive certainly underlies the need for academic achievement to the extent that such achievement represents to the learner the attainmnt of the knowledge he seeks to acquire It is completely *task oriented* in the sense that the motive for becoming involved in the task in question (acquiring a particular segment of knowledge) is intrinsic to the task itself—is simply the need to know, and hence the reward (the actual attainment of this knowledge) also inheres completely in the task itself since it is capable of wholly satisfying the underlying motive

A second component of achievement motivation on the other hand is not task-oriented at all It may be termed *ego enhancing* because it is concerned with achievement as a source of primary or earned status namely, *the kind of status that an individual earns in proportion to his achievement* or competence level It is ego enhancing inasmuch as the degree of achievement determining how much primary status he enjoys simultaneously determines how adequate he feels (his level of self-esteem) feelings of adequacy in this case always being a direct reflection of relative primary status The ego-enhancement component of achievement motivation is therefore directed both toward the attainment of current scholastic achievement, or prestige and toward the future academic and career goals (later sources of primary status) that depend on the latter One of its central ingredients as we shall see later, is anxiety—fear in response to any anticipated threat to the loss of primary status and self-esteem that results from academic failure Approval from teachers satisfies the ego-enhancement component of achievement motivation by constituting confirmation of achievement or a source of primary status

The final or *affiliative* component of achievement motivation is neither task-oriented nor primarily ego-enhancing It is not oriented toward academic achievement as a source of primary status but rather toward such achievement insofar as it assures the individual of the approval of a superordinate person or group with whom he identifies in a dependent sense and from whose acceptance he acquires vicarious or derived status The latter kind of status is not determined by the individual s own achievement level, but by the continuing intrinsic acceptance of him by the person(s) with whom he identifies And the individual who enjoys derived status is

It appears likely, therefore, that motivational factors influence retention—by raising thresholds of availability—only in those relatively rare instances where retrieval of particular information would be ego threatening or productive of anxiety, as for example, in the repression of memories that would if recalled, give rise to feelings of guilt or self disparagement These kinds of forgetting however, would not occur very frequently in typical classroom learning situations

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A second component of achievement motivation, on the other hand, is not task-oriented at all. It may be termed *ego-enhancing* because it is concerned with achievement as a source of primary or earned status, namely, the kind of status that an individual earns in proportion to his achievement or competence level. It is ego-enhancing inasmuch as the degree of achievement determining how much primary status he enjoys, simultaneously determines how adequate he feels (his level of self-esteem), feelings of adequacy in this case always being a direct reflection of relative primary status. The ego-enhancement component of achievement motivation is therefore directed both toward the attainment of current scholastic achievement, or prestige, and toward the future academic and career goals (later sources of primary status) that depend on the latter. One of its central ingredients, as we shall see later, is anxiety—fear in response to any anticipated threat to the loss of primary status and self-esteem that results from academic failure. Approval from teachers satisfies the ego-enhancement component of achievement motivation by constituting confirmation of achievement or a source of primary status.

The final or affiliative component of achievement motivation is neither task-oriented nor primarily ego-enhancing. It is not oriented toward academic achievement as a source of primary status, but rather toward such achievement insofar as it assures the individual of the approval of a superordinate person or group with whom he identifies in a dependent sense, and from whose *acceptance he acquires vicarious or derived status*. The latter kind of status is not determined by the individual's own achievement level, but by the continuing intrinsic acceptance of him by the person(s) with whom he identifies. And the individual who enjoys derived status is motivated to obtain and retain the approval of the superordinate person—by meeting the latter's standards and expectations, including those for academic achievement—since such approval tends to confirm his derived status

Varying proportions of the cognitive, ego-enhancement, and affiliative components are normally represented in achievement motivation, depending on such factors as age, sex, culture, social class membership, ethnic origin, and personality structure Affiliative drive is most prominent during early childhood when children largely seek and enjoy a derived status based on dependent identification with, and intrinsic acceptance by, their parents During this period they strive for academic achievement as one way of meeting their parents expectations and, hence, of retaining the approval they desire Actual or threatened withdrawal of approval for poor performance therefore motivates them to work harder to retain or regain this approval Since teachers are largely regarded as parent surrogates, they are related to in similar fashion

Affiliative drive is thus an important source of motivation for academic achievement during childhood As we shall see later however, children who are not accepted and intrinsically valued by their parents, and who therefore cannot enjoy any derived status, are compensatorily motivated to seek an inordinate amount of earned status through academic achievement. Thus high levels of achievement motivation typically represent low affiliative drive that is more than compensated for by high ego-enhancement drive

During late childhood and adolescence, affiliative drive both diminishes in intensity and is redirected from parents toward agemates Thus, academic competition against the opposite sex group or other age grade classes constitutes a powerful motivating factor (Maller, 1929, Sims, 1928) Desire for peer approval, however, may also depress academic achievement when such achievement is negatively valued by the peer group This is a more common occurrence among lower-class and certain culturally deprived minority groups (Ausubel, 1965g) Middle-class peer groups, as pointed out later, place a high value on academic achievement and expect it from their members

In most cultures, and particularly in Western civilization, ego-enhancement drive is the dominant component of achievement motivation in adolescence and adult life.[10] This is especially true among males and middle class groups in our culture For about a decade and a half after World War II,

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[10] Thus with increasing age material rewards are sought less as ends in themselves than as symbols of earned status prestige and ego-enhancement Remote goals also become more salient as long term ambitions displace the need for immediate hedonistic gratification, as the temporal dimensions of the child's psychological world expand and as his frustration tolerance increases

however, the drive for competence and earned status gave ground in the United States to the affiliative drive as epitomized by the character structure of the organization man " Affability, social poise, and ability to "get along," 'play it safe," equivocate, conform, and "swim with the tide" displaced initiative, competence, individualism, forthrightness, and moral courage as the dominant values in American society Then, partly in response to the challenge emanating from spectacular Soviet achievements in science and technology, traditional American values staged a remarkable but far from complete comeback during the sixties A new and emergent feature of this latter shift in cultural values is an almost cult like veneration of intellectual achievement and creativity

## *Efficacy of Ego-Enhancement Motivation*

The effectiveness of ego enhancement drive for academic achievement is borne out empirically by many kinds of evidence Achievement motivation leads to greater persistence and a higher rate of success in problem-solving situations (Feather, 1961, French and Thomas, 1958) and to higher short term (Kight and Sassenrath, 1966) and long term (Krug, 1959, Uhlinger and Stephens, 1960, Weiss, Wertheimer, and Groesbeck, 1959) academic performance Relative need for academic achievement discriminates significantly between normally achieving and underachieving men (Todd, Terrell, and Frank, 1962) In ego-oriented laboratory situations, as when successful completion of a task is represented to subjects as being reflective of intelligence, both level of motivation and performance level are enhanced (Alper, 1946, Kausler, 1951) Under achievement conditions, high need for achievement in high school boys is associated with greater meaningful learning of academic materials[11] (Caron, 1963) Finally, J B Miller (1929) and V M Sims (1928) found that individual rivalry stimulates academic performance more than group rivalry does, and D P Ausubel (1951) found that *gifted elementary school children work much harder at an academic task in* response to a prestige incentive than when they are merely trying their best but believe their work products are anonymous Achievement motivation, however, is not linearly related to achievement level As is the case with potent motivational status generally, very strong achivement motivation may lower the level of performance and achievement

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[11] Data from studies using thematic (fantasy) measures of achievement motivation tend to be equivocal because of the tendency in many instances for an inverse relationship to prevail between real life ' and fantasy indices of ego-enhancement drive

### *Advantages and Disadvantages of Ego-Enhancement Motivation*

The emphasis that has been placed on intrinsic motivation for learning should not be interpreted as a denigration of the importance of developing extrinsic motivations The need for ego-enhancement, status, and prestige through achievement and the internalization of long term vocational aspirations, are, after all, traditional hallmarks of personality maturation in our culture and educational aspirations and achievement are both necessary prerequisites for and stepping stones to their vocational counterparts Hence, in addition to encouraging intrinsic motivation for learning it is also necessary from the standpoint of personality maturation to foster ego-enhancement and career advancement motivations for academic achievement Furthermore few individuals ever develop enough cognitive drive to master large bodies of subject matter as an end in itself Long term ego-enhancement motivation is also necessary

One might legitimately even go a step further and assert the unfashionable view that aversive motivation, namely, the threat of those penalties associated with failure is as necessary as the positive motivation stemming from anticipated rewards for sustaining the long term academic achievement required for reaching professional goals Although educators theoretically decry the use of aversive motivation they implicitly rely on it to keep students studying regularly for their credits, degrees and diplomas They do this because they know that cognitive drive and anticipated reward for hard work are not sufficient to overcome both inertia and the typical human proclivity toward procrastination and aversion to sustained, regular, and disciplined work. Any teacher who imagines that the majority of his students would continue at their studies in the absence of structured programs, assigned work deadlines and examinations is living in a world of fantasy The motivational force of an examination lies more in the fear of failure than in the hope of success *Thus within reason, the threat of failure is a* pedagogically legitimate form of motivation Students study not only to avoid the actual consequences of failure but also to reduce both the anxiety which this threat generates and the guilt feelings that accompany lack of attention to academic duty

On the average, ego-enhancement motivation is undoubtedly the strongest motivation available during the active portion of an individual s academic and vocational career More than any other factor, it accounts for the persistence of high levels of aspiration (Ausubel and Schiff, 1955, Ausubel Schiff, and Goldman 1953a, Ausubel Schiff, and Zeleny, 1953b, P S Sears 1940) and task attractiveness (Schpoont, 1955) both in laboratory and real life settings, despite exposure to repeated failure experience Carried to an extreme, of course, this type of motivation may generate sufficient anxiety to disrupt learning (Ausubel, Schiff, and Goldman, 1953a), it may also lead to highly unrealistic academic and vocational aspirations that are later followed either by catastrophic failure and collapse of self esteem (Ausubel, 1956) or by disinvolvement from academic tasks as manifested by unrealistically low levels of aspiration (P S Sears, 1940) A related possibility is that excessively high needs for academic achievement may impair a student's capacity for perceiving his limitations, may predispose him to rationalize his failures, and may discourage him from acknowledging that his views are logically or empirically untenable

Still another disadvantage of exaggerated ego-enhancement motivation is that its utilitarian orientation limits its longevity Thus, a student whose academic motivation is principally extrinsic tends to perceive little value in a subject after he passes a course, or in continuing to learn after he receives his degree—if such knowledge is unrelated either to future course work or to vocational success In other words, he no longer evinces a desire to learn when he does not have to

Finally, overemphasis on academic achievement (assignments, examinations, grades) in such countries as France and Switzerland suggests that individuals normally manifest an upper limit of tolerance for academic stress and pressure, and that when this limit is reached relatively early in life it leads to disinclination for further academic striving in adult life A comparable phenomenon in the United States, attributable to the publish or perish climate in the early stages of a university career, is the premature burning out of academic motivation once the initial hazards of perishing are overcome

## Reward and Punishment

Rewards influence learning in three general ways First, by serving as incentives, they help set a meaningful problem by relating a specific sequence or organization of component responses to a specified goal outcome Without such goal relatedness, behavior would often tend to be amorphous and undirected Concomitantly, by providing significant information about the success or failure of responses, rewards give selective emphasis at critical choice points to desired or correct reactions, thereby facilitating discrimination between relevant and irrelevant cues Second, the actual receipt of rewards tends to augment, on a long term basis, whatever motivations (drives) are originally operative in energizing and directing behavior toward them (the rewards), that is, by satisfying certain drives at a given time, rewards strengthen, on a more permanent basis, those drives which they satisfy at the moment (or temporarily 'reduce ) Finally, rewards may increase the relative probability of response recurrence by selectively "sensitizing" to later lowering, the thresholds of elicitation of the particular responses that lead to obtaining the reward and thereby satisfy (or temporarily reduce) the drive in question This last property of rewards will be considered in greater detail in the next section under the heading of reinforcement, where the position will be taken that reinforcement occurs only in relation to rotely learned associations and instrumental responses and does not characterize meaningful learning outcomes

Punishment (in the sense of nonreward or failure to obtain the reward) acts as the reverse of reward in the following ways First, it also helps structure a problem meaningfully, furnishing direction to activity—and information about progress toward goal—in terms of what is to be avoided Thus, the unsatisfying consequences of an act tend to elicit avoidance, withdrawal, or variation rather than repetition, the individual learns which responses lead to nonreward and hence should be avoided Second, punishment tends to weaken, on a long term basis, the motivations energizing the behavior that is punished Lastly, punishment may decrease the relative probability of response recurrence, by failing to sensitize to later lowering, the thresholds of elicitation of the particular responses that lead to non reward It should be borne in mind, however, that the informational aspect of nonreward is less explicit than that of reward Although it does aid discrimination between correct and incorrect cues through the information it gives as to the consequences of an act, it is less directive and provides less guidance than reward It tells the individual only that something else must be done, but does not tell him *what* to do Reward, on the other hand, clearly indicates that the same response is to be repeated

It should be noted at this point, however, that "punishment" was con sidered above only in the sense of nonreward and not in the more active sense of the term In the animal learning literature, for example, it is cus tomary to distinguish between nonreward and *true punishment* on the grounds that nonreward unlike 'true punishment,' does not necessarily imply noxious or painful stimulation and is, therefore, both not necessarily threatening and not necessarily productive of anticipated fear and of the need to avoid painful, threatening stimulation, and this distinction is ac tually quite defensible in many animal learning situations where nonreward for learning merely frustrates an appetitive drive Nonreward is also not equivalent to punishment in relation to the purely cognitive drive component of human achievement motivation, since mere failure to acquire knowledge when knowledge is sought as an end in itself, is not particularly threatening In practice, however, because of the affiliative and ego-enhancement components of achievement motivation, failure to learn in the school environment almost invariably implies either the threat of disapproval or the threat of current and/or future loss of primary status and self esteem Thus, for all practical purposes, nonachievement or academic failure has all of the aversive properties of true punishment" To the effects of punishment, considered as nonreward, that are listed above, we must therefore add the drive to avoid the threatening implications of failure

Reward and punishment are positive and negative sides of the same motivational coin in school learning, and both are typically involved, in varying degrees, in motivating such learning It is admittedly more enlight ened from the standpoint of mental hygiene for the school to focus on re ward rather than on punishment, and to minimize rather than emphasize explicit threats of failure On the other hand, it is both unrealistic to deny the existence or effectiveness of punishment as a motivational variable in school learning, and unwarranted to deplore it as either immoral or pedagogically unsound

It has already been asserted that effective extrinsic motivation implies both reward and punishment Over the past four decades, however, the role of punishment in learning has been unwarrantedly denigrated by both psychologists and educators Confusion about the legitimacy and effectiveness of punishment as a motivational factor in learning may be attributed to five principal sources First, the progressive education movement fostered various child centered and permissivist views about the philosophical and mental hygiene impropriety of punishment Sentimentalists associated with this movement regarded punishment as unnecessary, authoritarian, and reactionary Education was supposed to be an exclusively happy and non anxiety producing experience, and in accordance with this gratuitous assumption, proper motivation for learning could be only intrinsic in nature or be instilled by positive incentives (reward) In support of this assertion, numerous straw man arguments were adduced (see below)

A second source of confusion is more semantic, emanating from failure to distinguish between the more restricted meaning of punishment in psy chology as the opposite of reward (as nonreward or as the threatening con sequences of failure to learn or perform successfully) and its more general meaning as a penalty for moral infraction (blame, rebuke, reproof, chastise ment, censure, reprimand) Thus the suggestion that punishment, in the more restricted sense of the term, be used for motivational purposes tends to arouse a storm of protest simply because of confusion with its more general meaning as retribution for moral wrongdoing Illustrative of such confusion is the use of the term "reproof as synonymous with "disapproval' in describing various classroom experiments comparing the relative effects of approval and disapproval on learning Actually, moral censure is never seriously advocated today for honest mistakes or failure to learn, but only for irresponsibility, laziness, culpable neglect, or inexcusable failure relative probability of response recurrence by selectively "sensitizing" to later lowering the thresholds of elicitation of the particular responses that lead to obtaining the reward and thereby satisfy (or temporarily reduce) the drive in question. This last property of rewards will be considered in greater detail in the next section under the heading of reinforcement, where the position will be taken that reinforcement occurs only in relation to rotely learned associations and instrumental responses and does not characterize meaningful learning outcomes.

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Third, critics of aversive motivation in the school environment apparently fail to appreciate that its objective is the facilitation of learning through the anticipated *threat* of failure (thereby overcoming inattention, procastination, laziness, and lack of effort), rather than through the actual application of the punishment itself Its aim, in other words, is to make the student *avoid* punishment by learning rather than to experience punishment by failing to learn Thus, in the vast majority of instances, serious punishment is never actually experienced because it is circumvented by the learning that is motivated by the fear of the threatened consequences of not learning

Fourth, frequently no distinction is drawn between the long term effects of failure itself in weakening the motivations energizing unsuccessful behavior, and in reducing the attractiveness of failed tasks, on the one hand, and the corresponding effects of anticipated threat of failure to self-esteem (of anxiety) Actually the evidence indicates that a high level of anxiety is associated with intense motivation, a high and sustained level of aspiration, and high task attractiveness, both for short term learning tasks and for academic achievement generally Similarly, it is frequently not appreciated that although failure has a disruptive effect on the quality of immediately following performance (R. R Sears, 1937, Waterhouse and Child, 1953), anxiety does not typically have a negative effect on learning unless the task is extremely unfamiliar or the level of anxiety is extremely high

Lastly, next to progressive education, B F Skinner has provided the chief ideological ammunition against the motivational use of punishment in learning According to Skinner (1948), positive reinforcement is the

[12] On the basis of two frequently cited experiments (Chase, 1932, Hurlock, 1924) it is generally held that praise is more efficacious than reproof' (disapproval) for classroom learning Other studies, however, either report equivocal findings (Schmidt 1941) or suggest that the relative effectiveness of the two practices depends on the personality of the child (Grace 1948, Thompson and Hunnicutt, 1944) or of the administrator (Schmidt, 1941) L. T. Frase (1963) recently reported that negative social reinforcement (implied disapproval) has a greater facilitating effect than positive social reinforcement (approval) on the learning of logic.

utopian key to all learning, hence, suitable programming should make learning tasks so easy that almost every response can be correct and thus be rewarded and positively reinforced (1958). Under these circumstances, there is little need for even nonreward to extinguish incorrect responses.[13] The actual doctrine regarding the ineffectiveness of punishment is generalized from two operant conditioning experiments (Skinner, *1938*, *Estes, 1944*) in which punishment (as contrasted to nonreward) was shown to lead to temporary suppression rather than to extinction of a simple, previously *reinforced learned response (lever pressing) requiring no discrimination* whatsoever. The difficulty with this line of reasoning, of course, lies in the fact that the extinction paradigm in this type of operant conditioning is hardly comparable to the typical situation in which threat of punishment is used to motivate classroom or laboratory learning.[14]

Contrary to Skinner's and Estes' findings, punishment, conditioned fear, and anxiety have been remarkably effective in a wide variety of avoidance training (Solomon and Brush, 1956), instrumental conditioning, and discrimination learning (Penney and Lipton, 1961) experiments. The object of threatened punishment in these experiments (as is also the case in classroom learning) was not to extinguish or induce *unlearning* of a simple and nondiscriminating type of previously reinforced response, but to motivate a more complex and discriminating variety of *original* learning by training the learner to avoid either a painfully cued choice or the pain associated with failure to learn or respond. It is quite probable, therefore, that punishment is more effective than nonreward in complex and discriminating instances of original learning both because it generates aversive motivation (motivation to avoid the punished response) and because it gives more informational emphasis to the alternatives that are to be avoided.

As pointed out above, caution is indicated in the application of aversive motivation. Used excessively, *it may generate a level of anxiety out of all* proportion to the actual risk of failure involved in a particular learning task. This may not only disrupt learning, but also generalize to other areas and induce a negative self-concept (an "emotional block") about entire fields of knowledge such as mathematics. It can also lead either to ego-disinvolvement from a task or to unrealistically high levels of aspiration. The

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[13] In point of fact, meaningful learning, as previously indicated, is sufficiently *complex and involves sufficient discrimination* that successful outcomes cannot be guaranteed by fragmentation of the learning task. It is also greatly facilitated by the purely cognitive or informational effects of nonreward or report of learning failure, particularly if such report is differential in nature.

[14] Even using an extinction paradigm, H. P. Weingold and R. L. Webster (1964) were able to extinguish previously reinforced cooperative behavior by punishment but not by nonreinforcement.

solution, however, is not to outlaw aversive motivation but to keep it within reasonable bounds, to balance it with cognitive and positive ego enhancement drives, to make learning more successful for most pupils, and to provide particularly anxious children with counseling

## Drive Reduction and Reinforcement

Whether drive reduction (temporary satisfaction of a need) has a selective reinforcing effect on drive reducing learning outcomes (thereby increasing their later availability or the probability of their recurrence), and how this effect is mediated, are exceedingly complex and controversial topics, full discussion of which is obviously beyond the scope of this chapter. It will suffice to take, and briefly to justify, the position here that. (a) drive reduction selectively reinforces drive reducing learning outcomes only in the *rote* learning of discrete, arbitrary, and verbatim associations or of instrumental stimulus-response connections, and (b) it does so not by retroactively and selectively increasing associative strength between stimuli or between stimuli and responses, but by retroactively and selectively sensitizing to later lowering, the thresholds of elicitation or availability of such associative units

In rote, as in meaningful learning, drives also merely energize and direct behavior nonspecifically and catalytically, whereas the actual strength of association that develops in the course of learning is determined by such factors as contiguity, frequency, primary, and the informational effects of reward It is also reasonable to suppose that the affectively satisfying effects of drive reduction may retroactively and selectively make more susceptible to later lowering the thresholds of availability of those particular associative units whose acquisition was instrumental in obtaining the reward The likelihood of this possibility is enhanced by evidence suggesting that· (a) affective and motivational factors can retroactively increase memory (lower thresholds of availability) for rotely learned items, and (b) a generalized drive state (for instance, hunger, sex) can selectively lower the thresholds of elicitation of those responses and perceptions that are particularly relevant for its satisfaction by virtue of their prior reduction of the drive during learning This effect of drives in selectively lowering such thresholds of elicitation can be explained most parsimoniously, in turn, by assuming that the retroactive satisfying effects of drive reduction on drive satisfying learning outcomes, makes them differentially sensitive to the general threshold lowering effects of drive states It is understandable, therefore, that when particular responses frequently satisfy a given drive, their thresholds of elicitation become pre-emptively sensitized to lowering whenever the drive in question is operative, and what applies generally in relation to a given drive also presumably applies to the satisfaction of the same drive in a particular learning task.

In the case of *meaningful* learning, on the other hand, no mechanisms exist through which the satisfying effects of reducing the cognitive, affiliative, and ego enhancing components of achievement motivation can reinforce successful (drive reducing) learning outcomes. Unlike the informational (cognitive) consequences of feedback (confirmation, correction, and clarification), which impinge directly on, and can therefore increase the dissociability strength of *previously learned* meanings, the affectively satisfying effects of drive reduction are not *intrinsically* related to the factors determining dissociability strength, and hence cannot increase it retroactively; they can increase it only indirectly *during* the course of learning by nonspecifically and catalytically enhancing learning itself. The possibility remains, of course, that the effects of drive reduction could be mediated retroactively through their influence on the thresholds of availability of meaningful learning outcomes—just as in the case of rotely learned items. However, there is no comparable evidence suggesting that motivational and affective factors can directly lower the thresholds of availability of meaningfully learned items. Apparently thresholds of availability, in relation to dissociability strength, differ in this crucial respect from corresponding thresholds of availability in relation to associative strength.

This does not mean, however, that reward and punishment do not facilitate meaningful learning in other ways. Reinforcement, after all, is only one consequence of reward—that aspect which directly increases the elicitability of *rotely* learned responses by sensitizing their thresholds of availability to later lowering when drive states are operative. In the case of meaningful learning, reward and punishment have two other more indirect kinds of facilitating effects. In the first place, from a motivational standpoint, awareness of successful learning (satisfaction of cognitive, affiliative, and ego enhancing drives for acquiring new knowledge) energizes subsequent learning efforts by enhancing the learner's self confidence, by encouraging him to persevere, and by increasing the subjective attractiveness of the learning task. At the same time it motivates the individual to make further use of, that is, to practice, rehearse, and perform what he has already learned, and also encourages him to continue developing and exercising the motives that were satisfied or rewarded, namely, the desire for knowledge both as an end in itself and as a means of enhancing status and self esteem.

The experience and threat of punishment (failure to learn successfully), on the other hand, generate considerable aversive motivation. The learner is thus generally motivated to avoid learning failure by paying attention, by displaying suitable effort and perseverance, by delaying the gratification of hedonistic needs, and so forth. In addition, when he is informed that a particular previously learned understanding is incorrect, the threatening implications of this report motivate him to some extent to avoid or reject it presumably raising thereby its threshold of elicitation [15] These facilitating effects of aversive motivation undoubtedly more than counterbalance the negative impact of failure experience itself on the long term strength of the underlying motivation and on long term task attractiveness However when experience of failure predominates or when aversive motivation is unsuccessful in averting failure this is obviously not the case

Second reward (awareness of successful learning outcomes) and punishment (awareness of unsuccessful learning outcomes) whether in relation to the intrinsic or extrinsic components of achievement motivation, also have all of the cognitive or *informational* effects of feedback These latter effects are probably just as important for meaningful learning and retention as are the motivational effects of reward and punishment. By confirming correctly understood meanings and at the same time indicating areas of confusion correcting errors and clarifying ambiguities and misconceptions the cognitive aspects of feedback increase the stability, clarity, and discriminability of meaningfully learned ideas (enhance their dissociability strength) increase the subject s confidence in the correctness of his understandings and enable him to focus his learning efforts selectively on inadequately learned portions of the material They not only have informational value for subsequent trials of the same learning task but also have transfer value for related new tasks (Keislar 1960)

### The Effects of Intention on Meaningful Learning and Retention

Although individuals can acquire much miscellaneous information and some skills incidentally deliberate effort is required for the efficient learning of most types of academic material Deliberate intention to learn (in response to explicit instructions) is not essential for learning as long as belongingness is present Such belongingness prevails even in the absence of

[15] Since the threat implied by any *particular* wrong learning is obviously not very formidable the elevation of its threshold of availability is only a very minor factor in forgetting misconceptions Many misconceptions are amazingly tenacious because of the influence of such factors as primacy and frequency because they are anchored to highly stable subsumers and because they are inherently more stable (more general less qualified expressive of a positive rather than an inverse relationship indicative of single rather than multiple causality) than their correct" counterparts.

explicit instructions, either when the learning material is potentially meaningful, or when habitual expectancies are applicable to rote learning tasks In the latter instances, of course, a certain amount of implicit or self instruction may be operative Nevertheless, many experiments show that deliberate learning in response to explicit instructions is both more effective (Bromer, 1942, Huang, 1944, G C Myers, 1913, H B Reed, 1946), and more precise and specific (Postman and Senders, 1946), than is unintentional or implicitly instructed learning To explain these findings it is only necessary to invoke the typical energizing and expediting effects of motivation on learning We have already considered why incidental practice, in the sense of being unstructured and uncontrived rather than unintentional, does not lead to efficient learning outcomes

Somewhat more important for long term school learning is the widespread belief that intention to *remember* facilitates the retention of meaningfully learned verbal materials Actually, however, the experimental evidence bearing in this issue is quite equivocal for one or both of two reasons the experimental arrangements have been such as (a) to induce *intentions* to learn rather than to remember, or (b) to make impossible the isolation of the effects of intention on learning from its effects on retention

Numerous studies, for example, have shown that intention to remember *enhances the longevity of retention When subjects learn material with* the expectation of recalling it for a designated period of time, recall is superior for the expected as against either a longer or shorter interval (Aall, 1913, Biel and Force, 1943, Geyer, 1930, Thisted and Remmers, 1932) O P Lester (1932) demonstrated that retention is facilitated by expectation of recall and by foreknowledge of the occurrence and possible interfering effect of interpolated materials Unfortunately, however, since these experiments introduced differential intentions to remember at the time of original learning, they did not isolate the effects of the intention on what was learned in the first place from its effects on retention alone Under the circumstances, therefore, all of the superior retention could be plausibly attributed to the energizing effects of the intention on learning without assuming that it had any independent influence on retention

To test this latter interpretation, D P Ausubel, S H Schpoont, and L Cukier (1957) conducted an experiment in which undergraduate students learned an extended historical passage and were then tested on it immediately afterwards After this test, an explicit intention to remember was induced by announcing that an equivalent form of the test would be given two weeks later The same procedure was followed with a control group except that an unannounced retest was administered The two groups were not significantly different in mean learning scores or in the percentage of material retained from test to retest *It was concluded, therefore, that intention* to remember in the previously reported studies primarily facilitated retention by enhancing learning rather than by virtue of any effect on the retention process itself The reason why positive ego involvements, such as intention to remember, presumably do not facilitate retention is because motivational variables, as postulated above, can neither influence dissociability strength after the material is already learned, nor lower thresholds of availability for meaningfully learned material

In another group of studies, it was shown that retention is superior (Maso, 1929, J Peterson, 1916, Prentice, 1943) and retroactive inhibition less marked (Prentice, 1943), when practice is accompanied by "intent to learn" than when learning takes place incidentally That this difference is largely attributable to superior original learning, however, is demonstrated by the fact that it no longer prevails when experimental and control subjects are equated for original mastery of the learning task (Biel and Force, 1943) In any event, the evidence yielded by such studies is at best indirect, because in each instance an explicit experimental set was induced to *learn* material for immediate reproduction rather than to *retain* it for an extended period of time

## Values and Attitudes

In addition to teaching subject matter schools also have an obligation to transmit to pupils the major values of our culture, including those (such as the social equality of persons irrespective of race, religion, and ethnic origin) that, unfortunately, are honored more in theory than in practice It is unnecessary either to pretend that this does not constitute indoctrination or to apologize for it, as long as the teaching aims at rational persuasion rather than at uncritical acceptance based primarily on emotional grounds The assimilation of values will, of course, tend to follow the developmental trends outlined above for motivation generally Younger children are naturally influenced more by considerations of personal loyalty and prestige suggestion, with increasing age, however, considerations of intrinsic ideational merit and ego-enhancement become more important. For example, college students who prepare statements of position contrary to their currently held beliefs tend to maintain these positions if they are rewarded (Bostrom, Vlandis, and Rosenbaum, 1961, W A Scott, 1957)

### *Changing Attitudes*

Although it is admittedly difficult through mere presentation of facts to change attitudes that are firmly established both on a cognitive and on an emotional basis, this can be accomplished if it is attempted systematically and if the implications of the facts for the attitudes in question are drawn *explicitly* A Bond (1940) demonstrated this to be the case in modifying racially prejudiced ideas through a special instructional unit on genetics Greater lasting change in attitudes can be affected if a two sided presentation of the issues is made (Lumsdaine and Janis, 1953) This approach not only discounts the counterarguments in advance, but is also less likely to give the impression of constituting biased propaganda The evidence is equivocal whether discussion leads to more lasting change of attitude than does mere presentation of a controversial position in lecture form, but it does appear that a greater change in opinion occurs if an individual plays the role of a sincere advocate of a given point of view (Janis and King, 1954)

Teachers, of course, are particularly concerned with pupils' attitudes toward school As pointed out previously, there is, unfortunately, progressive disenchantment with school as children climb the educational ladder Although part of this trend can undoubtedly be attributed to the progressive alienation of children from the adult world, much of it also reflects the school s failure in the past to stimulate and satisfy the child s interest in knowledge as an end in itself It is noteworthy, in this connection, that high school students who are satisfied with school generally out perform on achievement tests those who are dissatisfied with school (Brodie, 1964) This relationship between favorable attitude and achievement also holds true in such individual subject matter fields as biology (Garverick, 1964) In this same connection it may be noted that interests are better predictors of the completion of a given college curriculum than is ability (J W French, 1961)

## The Effects of Attitudes on Meaningful Learning and Retention

*Only relatively recently has it been recognized that cognitive, as well* as affective, factors account for the differential effects of positive and negative attitudinal bias on the learning of controversial material This recognition was largely an outgrowth of H Peak s theoretical formulation of attitude structure as consisting of an interrelated group of ideas organized around a conceptual nucleus and manifesting affective properties (1955)

Little doubt exists that the learner s prevailing attitude structure differentially enhances or inhibits the learning of controversial materials that are congruous and incongruous respectively, with it Both motivational and cognitive variables are probably involved in such differential learning outcomes When their attitudes toward the controversial material are favorable subjects are highly motivated to learn they put forth more intense and concentrated effort and relevant perceptual cognitive, and response thresholds are generally lowered. Furthermore, since the cognitive component of the attitudes in question is well-established the subjects possess clear, stable, and relevant anchoring ideas for incorporating the new material When, however, their attitudes toward the controversial material are unfavorable, all of these factors operate in precisely the opposite direction

In addition a strong need to reduce cognitive dissonance or incongruity—operating either as a generalized trait or aspect of cognitive style, or more specifically in relation to a particular set of strongly held beliefs—may lead to a closed minded attitude that obviously impairs ability to learn new ideas contrary to existing beliefs A person who summarily dismisses such new ideas on this basis fails to learn them adequately because he may not even be willing to read or listen to them, because he makes little or no effort to understand or reconcile them with existing beliefs, or because he selectively misunderstands distorts discounts or reverses their implications in accordance with his bias But although these motivational, quasi motivational, and affective components of negative attitudinal bias selectively inhibit, both specifically and nonspecifically the learning of controversial ideas contrary to belief (account for the low dissociability strength of these ideas), they probably affect retention only insofar as they adversely affect learning itself No channel exists for the purely affective motivational components of such bias to exert a direct influence on retention unless it arouses sufficient anxiety to elevate thresholds of availability

Several studies (A. L. Edwards, 1941, Levine and Murphy, 1943, Zillig, 1928) have demonstrated that controversial materials are learned most readily when they are consistent rather than inconsistent with the subject's evaluative framework But in none of the aforementioned studies, despite the fact that selective learning was attributed solely to affective mechanisms, was any attempt made to differentiate between the respective effects on learning of the cognitive and affective components of attitude structure D Fitzgerald and D P Ausubel (1963), however, conducted a classroom experiment, involving the ability of central Illinois high school students to learn the Southern point of view about the Civil War, in which the effect of the cognitive factor (knowledge about the Civil War period) was statistically eliminated The learning difference attributable to *affective* factors, or to attitudinal bias under these conditions, was in the predicted direction (in favor of the relatively pro-Southern or positively biased group), but was not statistically significant In this same study, two additional findings pointed to the influence of cognitive variables on learning outcomes Not only did cognitive organizers facilitate the learning of the controversial material but the more knowledgeable subjects, irrespective of attitudinal bias, were also better able to learn the material, presumably because they found it more discriminable from previously learned related ideas than did the less knowledgeable subjects

Further evidence concerning the role of cognitive factors in the effects of attitude structure on learning, comes from E E Jones and R Kohler's (1958) study of the interaction between attitudinal bias and plausibility in their effects on learning These investigators found that prosegregation subjects learned plausible prosegregation and implausible antisegregation statements better than they learned implausible prosegregation and plausible antisegregation statements The reverse was true of the anti segregation subjects Evidently, plausibility enhanced the learning of the position favored by a particular subject and inhibited the learning of the position he opposed This suggests that controversial material is learned least well when it is least relatable to the prevailing ideational component of attitude structure—when favorable material is implausible and unfavor able material is plausible

L Gustafson (1957) found that members of three different American ethnic groups selectively learned best those facts about American history and culture that pertained to their own ethnic group This finding held up even when general knowledge of American history and culture was held constant But since the effects of specific knowledge of own group culture (in relation to which the differential learning was manifested) were not con trolled, the influence of ideational factors on learning outcomes was not eliminated *The results of this study are, therefore, consistent with the hypothesis that both cognitive and motivational mechanisms account for the effects of positive ego-involvement on learning*

### *Retention*

In many studies (Alper and Korchin, 1952, Clark, 1940, Watson and Hartmann, 1939) of the effects of attitude structure on retention, no measure *of initial learning was obtained Hence, there was no certain way of ruling* out the possibility that selective differences in retention (in favor of the group positively biased toward the material) were wholly attributable to attitudinal effects on learning In some studies (A L Edwards, 1941, Levine and Murphy, 1943, Taft, 1954), however, where retention was measured both immediately after learning and at subsequent intervals thereafter, original differences in learning between positively and negatively biased groups were found to widen progressively during the course of the retention interval *These latter findings suggest that attitude structure exerts an additional* facilitating influence on retention that is independent of its cognitive and motivational effect on learning

But although attitudinal variables undoubtedly facilitate the learning of controversial material through both cognitive and motivational mechan isms, it is likely that cognitive factors alone mediate most of the effects of attitude structure on *retention* In the first place, as pointed out earlier,

Chapter 11

# PERSONALITY FACTORS IN LEARNING

HOW DO PERSONALITY FACTORS ENTER into the learning process and how are their effects similar to and different from motivational and cognitive factors? In the first place, like motivational variables, personality factors deal with subjective and affective-social rather than with objective and intellectual aspects of learning. This means that they typically affect meaningful learning *nonspecifically and catalytically* rather than being directly and specifically involved (like readiness, cognitive structure variables, intellectual ability, and cognitive style) in the parameters of the cognitive interactional process. Second, like measures of intellectual ability and cognitive style (and unlike motivational variables), personality factors deal with stable and self-consistent *individual differences* in learners, but in the affective-social rather than in the cognitive domain.

In other words, it is not sufficient for the educational psychologist to be able to make generalizations and *actuarial* predictions about the *average* effective on classroom learning of either cognitive or motivational variables in a *group* of individuals. It is also important that he endeavor (a) to determine the impact on learning of stable individual differences, both cognitive and affective-social, and (b) to ascertain whether general cognitive and affective-social variables affect learning processes and outcomes differently for individuals who are bright rather than dull, who tend to be levelers rather than sharpeners, who are primarily motivated by ego-enhancing rather than by cognitive and affiliative drives, who manifest a high rather than a low level of anxiety, or who tend to be open rather than closed to new ideas.

In this chapter we cannot consider all kinds of personality traits (generalized, stable, and self-consistent behavioral tendencies in the affective-social domain), but only those selected personality variables that have been shown significantly to influence learning effort, value assimilation, and problem solving style The most important of these variables are motivational orientation to learning anxiety level dogmatism, authoritarianism, tendency to conform and personality adjustment

## Motivational Orientation to Learning

In the previous chapter, in addition to discussing cognitive drive we distinguished between two essentially different extrinsic components of achievement motivation One component, termed *affiliative drive,* is oriented toward vicarious or derived status, it is not concerned with achievement as a source of primary or earned status, but only insofar as it secures the approval of, and hence signifies continued intrinsic acceptance by, superordinate persons (parents, teachers) or groups with whom the learner identifies The other component, termed *ego enhancement drive,* is concerned with achievement as a source of earned status It was pointed out that affiliative drive is typically predominant during the preschool and elementary school periods, and is then gradually superseded by ego enhancing drive, particularly during adolescence But it is important to *recognize that although this is the typical developmental state of affairs,* and that even though cognitive, affiliative, and ego enhancing components are invariably present in the achievement motivation of all learners, their relative proportions tend to vary depending on both individual interpersonal experience with parents and cultural and social class factors[1] In this section we shall examine the developmental basis for individual differences in the relative strength of affiliative and ego enhancement drives and the consequences of these differences for degree of achievement motivation, for mode of assimilating values, and for academic achievement

### *Satellization versus Nonsatellization*

Whenever interpersonal and group life is characterized by differences in roles and status, and by dependence of one person on another or on the group as a whole, one of the more basic kinds of human interaction that arises under such conditions is identification of the dependent party with

[1] Not infrequently also as a result of continued successful experience, motivations that are originally absent in a given learning activity are developed afterwards during the course of that activity A rejected child, for example, may seek originally to achieve competence in some academic field solely for compensatory ego-enhancement Eventually however, he may develop genuine task oriented interests that are functionally autonomous of his original motivation

the superordinate party This type of relationship includes in varying proportions the elements of dominance subordination leadership-followership and care dependency described by J P Scott (1953) for different infra human vertebrates Much confusion however results from the failure to distinguish between two essentially *different* kinds of identification each of which involves a reciprocal relationship between a relatively dependent and subordinate individual on the one hand and a relatively independent or dominant individual (or group) on the other (Ausubel 1952)

One type of identification which is characteristic of the early parent child relationship in humans may be called *satellization* (Ausubel 1952) In a satellizing relationship the subordinate party (child) renounces an independent earned status of his own and accepts a status dependent on that of the superordinate party (parent) that is identifies in a dependent sense with the parent s status and the superordinate party in turn accepts him as an intrinsically valuable entity in his personal orbit The satellizer thereby acquires a vicarious or derived biosocial status which (a) is wholly a function of the dependent relationship and independent of his own competence or performance ability and (b) is bestowed upon him by the fiat of simple unqualified acceptance by a superordinate individual or group whose authority and power to do so are regarded as unchallengeable.

On the other hand the two parties to the same transaction could relate to each other in quite a different way The subordinate party—in this case a nonsatellizer—could acknowledge his dependency simply as a temporary regrettable and much to be remedied fact of life requiring as a matter of expediency various acts of conformity and deference but without really accepting a dependent and subordinate status as a person (Ausubel 1952) In turn he either could be rejected outright or could be accorded acceptance—not unqualifiedly as an individual for himself—but in terms of his current or potential competence and usefulness to the superordinate party The act of identification if it occurs at all consists solely in the child using the parent as an emulatory model so that he can learn the latter s skills and methods of operation and thus eventually succeed to his enviable status And accordingly the only type of biosocial status the child can hope to enjoy in this type of relationship is a primary (earned) status that reflects his own degree of functional competence or performance ability

The nonsatellizing type of identification occurs primarily for one or both of two reasons Either the superordinate party does not extend unqualified intrinsic acceptance (the parent who either rejects his child or values him basically for extrinsic, ulterior self-enhancing purposes of his own) or the subordinate party is reluctant to or incapable of accepting a dependent role Illustrating the latter possibility is the typical cat who condescendingly does his master a favor by drinking his milk in contrast to the typical dog who simply oozes devotion, slavishness, and self effacement It would also be reasonable to expect that children who are temperamentally more assertive, self sufficient, independent, and "thick skinned" would be less disposed to satellize than children with the opposite set of characteristics Differences related to culturally determined social sex role might also be anticipated For example, an experimental population of 10 year-olds in Champaign, Illinois (Ausubel, Balthazar, Rosenthal, Blackman, Schpoont and Welkowitz, 1954a) rated thirty six items of parent attitude and behavior reflective of acceptance rejection and intrinsic extrinsic valuation Analysis of the ratings confirmed the hypothesis that girls are (or perceive themselves to be) more highly accepted and intrinsically valued than are boys

EFFECTS ON ACHIEVEMENT MOTIVATION From the standpoint of school learning, the wider significance of satellization versus nonsatellization in early personality development is the each of these outcomes is associated both with a distinctive pattern of achievement motivation and with a distinctive mode of assimilating norms and values Generally speaking, the non satellizer exhibits a much higher level of achievement motivation in which the ego-enhancement component is predominant, whereas the satellizer exhibits both a lower level of achievement motivation and one in which the affiliative component tends to predominate prior to adolescence

The satellizer identifies with his parents in a dependent sense and is accepted by them for himself He enjoys by the fiat of this acceptance, both an assured derived status and the accompanying feelings of intrinsic adequacy or self-esteem that are relatively immune to the vicissitudes of achievement and competitive position Thus he has relatively little need to seek the kind of status that he would have to earn through his own competence—the kind of status that would generate feelings of extrinsic adequacy commensurate with his degree of achievement He does not, in other words, view academic achievement as the basis of his status or as the measure of his worth as a person, it is merely a means of meeting the expectations of his parents and of retaining thereby the approval that confirms for him his good standing in their eyes

The nonsatellizer, on the other hand, is either rejected, or accepted on an extrinsic basis by his parents Enjoying no derived status or intrinsic self-esteem, he has no choice but to aspire to a status that he earns through his own accomplishments Since his feelings of adequacy are almost entirely a reflection of the degree of achievement he can attain, he necessarily exhibits a high level of aspiration for academic achievement and prestige—a level that is much higher, and more tenacious in the face of failure experience, than that of satellizers This is obviously a compensatory reaction on his part that reflects his lack of derived status and intrinsic self-esteem Consistent with his higher aspirations for achievement, he manifests more volitional and executive independence than the satellizer, and is better able to defer the immediate gratification of hedonistic needs in order to strive for more long term goals (Ausubel, Balthazar, Rosenthal, *et al*, Blackman, Schpoont, and Welkowitz, 1954a) Similar personality differences between individuals manifesting ego enhancement and affiliative drive orientations to learning, respectively, were reported by J W Atkinson and G H Litwin (1960) and by D C McClelland J W Atkinson, R A Clark, and E L Lowell (1953) As will be pointed out shortly, however, higher achievement motivation does not necessarily lead to higher academic achievement, in any case, this relationship is complicated by age and sex factors

Other aspects of the parent child relationship are also implicated in the development of achievement motivation Achievement motivation tends to be higher in those children whose parents have high intellectual achievement aspirations both for themselves (Katkovsky, Preston, and Crandall, 1964a and b) and for their offspring (Rosen and D Andrade 1959), whose parents stress independence training and high standards of excellence (McClelland, Atkinson, Clark and Lowell, 1953, Winterbottom, 1958), and whose parents, when present in problem solving situations with their offspring exhibit greater participation, instigation, encouragement, and disapproval (Katkovsky, Preston, and Crandall, 1964b, Rosen and D Andrade, 1959) It is also apparently stronger in instances where an achievement oriented mother is dominant in the home, a dominant, demanding, and successful father on the other hand, is perceived by his sons as providing a competitive standard that is too overwhelmingly superlative to be challenged successfully (Strodtbeck 1958)

Significant normative fluctuations (as well as individual differences) in the balance between primary and derived status occur throughout the course of ego development But as already indicated initial ways of relating to others tend to persist, especially if they occur at critical periods of socialization Thus although it is true that as the satellizing child grows older he increasingly strives for primary status, he will, even as an adult, continue to enjoy the residual sense of intrinsic worth which his parents earlier conferred on him and will continue to satellize in some aspects of his current interpersonal relationships

EFFECTS ON VALUE ASSIMILATION In addition, the satellizing and non satellizing modes of identification have important implications for the mechanisms by which norms and values are assimilated from elders and from membership and reference groups The essential motivation directing the satellizer s organization of his value system is the need to retain the acceptance and approval of the persons or group that provide his derived status Hence, he develops a generalized set to perceive the world in the light of the values and expectations he attributes to the latter individuals Value assimilation is thus an act of personal loyalty in which the actual content of what is internalized is largely irrelevant, that is, from a motivational standpoint The nonsatellizer, on the other hand, is primarily motivated, in his orientation to values, by considerations of expediency and attainment of primary status, and, hence, his motivational set is *not* to accept values blindly and uncritically but in accordance with these general aims The prestige suggestion of authority figures, in this instance, is not derived from the learner s need to agree with them, but from his acknowledgment of their suitability as emulatory models and stepping stones to power and prestige Nonsatellizing elementary school children are more disposed than satellizing children to disagree with the perceived opinions of their parents (Ausubel, Balthazar, Rosenthal, Blackman, Schpoont, and Welkowitz, 1954a)

When ideas are accepted on a satellizing basis, resistance to new learning stems largely from conflicting ideological trends in the new set of values, which can be accepted only at the cost of repudiating prior loyalties and assuming the associated burden of guilt Nevertheless, this must take place before new values can be assimilated The satellizer feels secure in his derived status only as long as approval is forthcoming He finds disapproval threatening and, when incurred through disloyalty, productive of guilt feelings In the case of the nonsatellizer, on the other hand, new ideas are resisted because they constitute a potential threat to self esteem by challenging (a) the existing system of values organized on an ego prestige basis, and (b) various presumptions of independence, originality, infallibility, and omniscience Because he lacks intrinsic feelings of worth and is therefore more vulnerable to the ego deflating implications of failure, he is more reluctant than the satellizer to venture into new areas of learning where his capability still remains to be demonstrated, such learning activities, in any case, are highly threatening until success is assured Resistence to new learnings, as well as to new values, is usually overcome when he is able to perceive their usefulness for future ego-enhancement

The different motivational orientations toward learning characterizing satellizers and nonsatellizers, respectively, suggest differential interpersonal handling on the part of teachers On theoretical grounds satellizers should learn best in a warm and supportive interpersonal environment in which they can relate to teachers as parent surrogates It has been shown that they achieve best when teaching methods are indirect rather than direct (Amidon and Flanders, 1961) Teachers must always guard against the tendency of satellizers to overconform to their directions and expectations (Kagan and Mussen, 1956, Livson and Mussen, 1957) Both their resistance to and acceptance of new values stem largely from considerations of personal identification and loyalty Nonsatellizers, on the other hand, require teacher approval as objective evidence of achievement rather than as confirmation of personal acceptance They resist accepting new values not because of loyalty to parents but because they tend to feel threatened by unfamiliar ideas By the same token, novel learning tasks and methods of instruction should be presented to them gradually, with as much prefamiliarization as possible Overcritical, deprecatory, demanding, and authoritarian teacher behavior appears to raise the anxiety level of anxious nonsatellizers, precipitating hostility, aggressiveness and withdrawal, accepting and supportive treatment, on the other hand, lowers their anxiety level and promotes more task-oriented and integrative behavior (Flanders, 1951)

EFFECT ON SCHOOL ACHIEVEMENT It is self-evident that an excess of ego enhancement drive or achievement motivation can have long term effects on school achievement only if it is a highly stable and somewhat generalized personality trait Research data clearly indicate that both of these conditions actually prevail The impressive evidence of stability characterizing achievement motivation from age 6 to adult life (Moss and Kagan, 1961) undoubtedly reflects, in large measure, the strongly enduring properties of ego-enhancement drive derived from the parent child relationship It is also a reasonably generalized trait, as can be inferred from the moderately high intercorrelations both (a) among level of aspiration and goal tenacity scores over a wide variety of laboratory tasks and real life' achievement situations, and (b) among goal tenacity scores over a broad range of hypothetical vocational situations (Ausubel and Schiff, 1955, Ausubel, Schiff, and Zeleny, 1953b) Furthermore, adolescent boys who have strong needs for vocational prestige tend to make high vocational tenacity scores and to be unrealistic, from the standpoint of their basic interest patterns, in their choice of vocations (Ausubel Schiff and Zeleny, 1953b) Interestingly enough, these findings do not hold true for adolescent girls since girls in this age group who, by interest or ability are attracted to high prestige occupations, are not similarly driven by the culture to actualize their ambitions, and hence need not be so unrealistic and tenacious in their vocational behavior Finally, high levels of aspiration in both academic and laboratory situations tend to be associated with a high level of anxiety and with poor personality adjustment (Ausubel, Schiff, and Goldman, 1953a, Ausubel, Schiff, and Zeleny, 1953b, Eysenck 1947, Hartogs, 1950)

The actual effect of motivational orientation to learning on school achievement depends on many factors—age, sex, anxiety level, and other personality traits Thus, although it is empirically demonstrable that high ego-enhancing drive (reflective of parental rejection or extrinsic acceptance) *generally* leads to higher levels of aspiration (Ausubel, Schiff, and Goldman, 1953a), the school performance of these individuals is not necessarily superior to that of intrinsically accepted pupils of comparable academic ability. In some individuals the corollary need for avoiding failure is so much stronger than the need for success that the level of striving is grossly lowered to pre vent even the remotest possibility of failure experience Other individuals with high achievement motivation lack the personality traits (persistence, self denial, high frustration tolerance, ability to defer hedonistic gratification) necessary for implementing high aspirations, merely aspiring high, without ever intending to implement the aspirations in question, yields a certain compensatory measure of ego enhancement

A third factor interfering with the facilitating effect of high ego enhancement drive on academic achievement is a disablingly high level of anxiety, particularly *the kind that leads to withdrawal from competitive* situations or to paralysis of adaptive behavior Lastly, cultural influences mediated through age and sex role expectations are important determining factors Thus, low nurturant and unaffectionate mothers tend to have daughters (but not sons) with superior school achievement in the elementary school (Crandall, Dewey Katkovsky, and Preston, 1964), since this is a culturally sanctioned form of compensatory ego enhancement for girls at this age level At the late adolescent and young adult level, on the other hand, the much greater cultural stress on male vocational achievement is apparently responsible for the association of parental rejection with high anxiety and academic achievement in male but not in female prospective teachers (Gnagey, 1966)

## Anxiety and School Learning

Anxiety must be differentiated from other kinds of fear like states Generically, it refers to an actual phobic response or to a tendency to respond with fear to any current or anticipated situation which is perceived as a potential threat to self esteem It differs from ordinary fear in that the threat is directed against self esteem rather than against physical well being and may be anticipated or current in nature A person is fearful when a mad dog lunges for his throat, he is anxious when he experiences or contemplates the loss in self esteem that results from vocational failure Anxiety differs, likewise from feelings of insecurity, which are similar to fear but arise only in response to *anticipated* threat, in the fact that the threat eliciting anxiety is specifically directed against the individual s self esteem and not against his physical safety In many situations however, insecurity and anxiety are aroused concomitantly The threat of possible vocational failure, for example is not only damaging to one s self regard but also generates genuine apprehension regarding one s chances for survival

### *Normal versus Neurotic Anxiety*

Within the generic meaning of the term, as defined here, one can conceive of several qualitatively different varieties of anxiety arising under basically different conditions of instigation Situationally for example anxiety is generated in medical students when they are confronted with important examinations that threaten the achievement of a life goal closely identified with their sense of adequacy One can induce a similar type of situational anxiety experimentally by giving subjects bogus reports which reflect adversely on their competence or personality integration Anxiety is aroused during transitional periods of personality development such as adolescence when individuals have to achieve a new biosocial status and are kept in a prolonged state of uncertainty regarding the outcome Feelings of hostility can generate anxiety by threatening an individual with loss of status as a result of antagonizing persons on whom he is dependent. Similarly feelings of guilt can generate anxiety by exposing an individual to a sullied reprehensible portrait of himself at odds with the moral values he has internalized.

These different varieties of normal anxiety have one property in common which distinguishes them from neurotic anxiety In each situation described anxiety is instigated by an *objectively* dangerous threat to self esteem In some instances this threat may be external in origin—as for example the crucial examination in the case of medical students or the need to acquire adult status under conditions of uncertainty in the case of adolescents In other instances the source of the threat is within the person —it may come from aggressive impulses or from the individual s awareness that he has violated certain of his moral scruples The important thing in all of these cases—regardless of whether the source of the threat is internal or external—is that the threat is objectively capable of impairing self esteem in normal persons In all cases the threat comes from a source distinct from the entity that is being threatened in no case does the threat to self esteem arise from impaired self-esteem itself In all cases the response to the threat is appropriate and proportionate to the objective degree of jeopardy confronting the individual s self-esteem

In neurotic anxiety on the other hand the essential source of the threat to self-esteem does not lie outside self esteem but is to be found in catastrophic impairment of self-esteem itself Hence a person suffering from neurotic anxiety apparently over reacts with fear to a perceived threat. But this over reaction is an over reaction only when considered in relation to the ostensible source of the threat to self esteem—the threat lying outside self-esteem which precipitates the anxiety It is not an over reaction when it is considered in relation to the major source of threat to self-esteem which lies *within* self-esteem itself Highly anxious children manifest more self dissatisfaction and self-disparagement than low anxious children (Lipsitt 1958 Phillips Hindsman and Jennings 1960)

The distinction between normal and neurotic anxiety can be highlighted with an analogy from heart physiology When a person has a normal undamaged heart how can he develop heart failure? It is not very easy He has to be subjected to tremendous exertion without rest prolonged exposure to heat severe pulmonary disease, and so forth The threat to cardiac adequacy when one has a normal heart, therefore lies in an objectively punishing situation Less rigorous threats to cardiac adequacy are easily compensated for because of the great reserve of power of the heart If the heart shows signs of beginning to fail when the external pressure increases, *the outcome is hardly disproportionate to the degree of strain involved*

But a person with a damaged heart has already exhausted all of his power to compensate for increased external demands Require him to run up a flight of stairs quickly, and he will be thrown into heart failure In his case, the source of the threat to cardiac adequacy lies in his own damaged heart muscle, just as the source of the threat to self-esteem in a person with neurotic anxiety lies in his own damaged self esteem Certainly he is over reacting with signs of cardiac insufficiency to a flight of stairs, just as the anxiety neurotic is over reacting to a new adjustive situation with signs of fear and further impairment of self esteem But in neither case is the reaction disproportionate to the actual degree of jeopardy confronting the heart or self esteem

### *The Origin of Neurotic Anxiety*

How do anxiety neurotics develop catastrophic impairment of self esteem so that they over react with fear to perceived threats to self esteem? A definitive answer to this question cannot be given at this time because there is as yet no definitive evidence But considerations of normal personality development as well as clinical study, suggest that an individual can never develop neurotic anxiety as long as he enjoys intrinsic feelings of self esteem, by which is meant a deep inner conviction that he is important and worthwhile for himself—apart from what he can do or accomplish, and apart from the position he holds in life (Ausubel, 1956) As long as he possesses this intrinsic self-esteem, failure in achieving superior competence or status is intense, deeply felt discouraging—but always peripheral to basic self esteem, and hence never catastrophic However, if he has to rely on success in school performance or vocation for whatever self esteem he enjoys catastrophic impairment following some very traumatic failure experience is much more possible If such failure occurs it is not peripheral but central—*since* there is *now* no *basis whatsoever (intrinsic or extrinsic)* for a feeling of worth as a human being The individual s sense of adequacy being purely a function of his competence or reputation, little self regard can remain if these are seriously undermined

Feelings of intrinsic self esteem as we have already seen, can develop only in one way—from a child identifying in a dependent sense with his parents He can do this if he perceives that he is accepted and valued for himself His all powerful, omniscient parents can endow all objects, including him, with intrinsic value if they so desire If they respond to him as a person who is worthwhile and important in his own right—just because they accept him as such—he tends to react to himself in the same way, since he has no other standards of value but theirs He thus acquires an intrinsic sense of adequacy, a vicarious status which is derived from his dependent relationship to his parents, and which is independent of his actual competencies As he becomes older, he will increasingly strive for a more primary status based upon his own accomplishments, and will develop feelings of self-esteem related to them But there will always remain a residual sense of worth which his parents conferred on him by fiat—when as a child he perceived this to lie within their power

As pointed out above however, not all children are fortunate enough to be accepted and intrinsically valued by their parents Some are rejected outright, and others are accepted but extrinsically valued, that is, accepted only in terms of their potential capacity for enhancing their parents egos by becoming important and successful individuals Such children do not undergo dependent identification with their parents, since they cannot acquire any vicarious status or intrinsic feelings of self-esteem from such a relationship From the very beginning their self-esteem becomes a function of what they are able to do and accomplish, and, hence, becomes very vulnerable to catastrophic impairment

Of course vulnerability to catastrophic impairment of self-esteem does not, in itself guarantee that such impairment must inevitably occur However, this catastrophic impairment frequently occurs for another related reason It has already been pointed out that when individuals lack intrinsic feelings of self-esteem, they are compensatorily motivated to aspire to higher goals and ambitions than the general run of mankind This is hardly surprising when one considers that the less adequate an individual feels intrinsically the more need he has to prove his adequacy to himself and others by superior accomplishments In a learning experiment with anxious subjects, for example, it was found that their levels of aspiration, in relation to previous performance and to prior feelings of failure, were significantly higher and more tenacious than those of nonanxious subjects (Ausubel, Schiff and Goldman 1953a) This means that their aspirations were more unrealistic, that their goals were not only too high but were also extremely resistive to lowering in the face of realistic indications for so doing Sarason, and others (1958) also found that high anxious children were less task oriented and had higher achievement motivation than low anxious children

Thus it seems reasonable to expect that rejected and extrinsically valued children who have no intrinsic feelings of self-esteem, will tend to set their academic and vocational goals high, and often unrealistically high If they happen to be extremely able individuals, all may go well, and they may achieve in accordance with their aspirations. However, there is no reason to believe that such rejected and extrinsically valued individuals tend to be more than usually gifted, and there are limits to what motivation alone can accomplish. Hence, the chances for large scale collapse of their grandiose and unrealistic aspirations are rather good, and since they have no intrinsic self-esteem to fall back upon, a defeat is centrally traumatic to self-esteem and commonly precipitates acute anxiety. Recovery from this condition, furthermore, tends to leave a permanently damaged self-esteem or, in other words, a chronic anxiety neurosis, which may flare up at any time and become acute when the environment becomes too threatening.

## *Effect of Anxiety on Learning*

We have postulated that "personality" (neurotic) anxiety is the phobic overreaction of an individual with impaired self-esteem to the threat anticipated in adjustive situations. The threatening implications of the latter are derived from their capacity to further impair self-esteem in the face of an inner feeling of inadequacy to cope with them. Normal anxiety, on the other hand, is the fear evoked by anticipation of objectively hazardous threats to self-esteem. Normal subjects do not display anxiety when confronted with ordinary adjustive situations, because they do not lack confidence in their ultimate capacity to acquire the necessary adaptive responses.

The relationship between anxiety and learning is complicated by the fact that although high anxiety individuals exhibit more than average *motivation*, (that is, although they tend originally to manifest an excess of ego-enhancement drive and are further driven to achieve as the only practicable means of reducing anxiety), their high level of anxiety also tends to have a disruptive effect on *novel* problem solving. Thus, it has been generally found that anxiety facilitates rote and less difficult kinds of meaningful reception learning, but has an inhibitory effect on more complex types of learning tasks that are either highly unfamiliar or are more dependent on improvising skill than on persistence (Ausubel, Schiff, and Goldman 1953a, Caron, 1963, Castenada, Palermo and McCandless, 1956, Lantz, 1945, McGuigan, Calvin, and Richardson, 1959, Marks and Vestre, 1961, Palermo, Castenada, and McCandless, 1956, Pickrel, 1958, Russell and Sarason, 1965, Sarason, and others 1960, Stevenson and Odom, 1965, Tomkins, 1943, Zander, 1944). The latter kinds of learning situations are obviously highly threatening to anxious individuals and tend to induce a disabling level of anxiety. It does appear, however, that anxiety may *enhance* the learning of complex tasks when they do not seriously threaten self-esteem—when they are not inordinately novel or significant (Van Buskirk, 1961, Wittrock and Husek, 1962), when the anxiety is only moderate in degree, or when the learner possesses effective anxiety coping mechanisms (Suinn, 1965) The learning of complex verbal materials in a typical school setting for example, seems to be a relatively familiar and nonthreatening task as compared to novel problem solving situations

These findings make sense when one considers that it is prescisely with respect to the need for improvising solutions to *novel* problems that the individual with personality anxiety experiences feelings of inadequacy Since such problems pose an exaggerated threat to his self esteem and sensitize him to overrespond with fear when he is obliged to face up to them, it follows that he can mitigate his anxiety most easily by removing, as best as he can, the element of improvisation from the problem solving process The response set of the neurotically anxious individual, therefore, is to avoid putting his improvising ability to the test and frantically to search his *available* response repertory for an appropriate solution that would not involve any reorganization of existing patterns However, if it so happens that the problem is one that requires improvisation for solution, this in flexible response set to avoid improvisation will not only inhibit learning, but will also render learning impossible until the set is eventually aban doned

Thus, to the panic that results from anticipatory over reaction to any new situation is added the panic resulting from initial failure to make any progress toward solution The cumulative impact of this disorganization may be disabling enough to induce blocking of response (Hartogs, 1950) which, in turn, may stimulate a face saving attempt to produce *any* kind of response regardless of how inappropriate or unadaptive Later, with in creasing exposure to the problem—providing that the panic is not too catastrophic—the individual may become sufficiently desensitized to its unfamiliarity and fear instigating properties to recover from his disorganiza tion and adopt a more efficacious (improvising) response set

In one experimental study of the effects of anxiety on learning (Ausubel, Schiff and Goldman, 1953a), university undergraduates who showed either low or high levels of endogenous anxiety were required to solve a stylus maze blindfolded This situation constituted a mild form of threat to self esteem If the subject was not able to solve the problem, he demonstrated to the experimenter and to himself that he was not very good at a certain type of learning (Even rats are reputed to learn to solve mazes) For all of the subjects in this study, the maze represented a novel learning task for which past experience was not only of no help but was actually a hindrance Successful solution of the problem could not be accomplished without im provisation

The low anxiety subjects with normal self-esteem tended to assume that they could learn to improvise successfully with a little practice And if they failed, so what? So they weren t good at solving mazes blindfolded The high-anxiety subjects had a different orientation Lacking normal self-esteem, they lacked confidence in their ability to cope with new adjustive situations They were frightened when their habitual visual learning cues were removed, when they had to improvise And lacking any intrinsic feelings of adequacy they were naturally very dependent on the self esteem they could achieve through successful performance Thus, they could less afford to say, So what? to failure

What were the results? The high anxiety subjects *apparently* over reacted to the threat to self esteem emanating from the maze situation The real threat, however, came from their own impaired self esteem And in terms of *that* threat they certainly did *not* over react On the first trial of the maze they became panicky and flustered making a significantly greater number of errors than the low anxiety subjects But after the first trial the maze was no longer a new learning task requiring improvisation It became more and more familiar and old hat By the end of ten trials, there was no longer a significant difference between the two anxiety groups

The role of novel adjustive situations that demand improvisation, in investigating anxiety in neurotically anxious subjects was demonstrated in a corollary experiment (Ausubel Schiff, and Goldman, 1953a) When high anxiety subjects were allowed to practice on an easier maze, first with and *then without vision they benefited significantly more from this advance* preparation than did low anxiety subjects Consistent with these findings, highly anxious subjects show less curiosity than nonanxious subjects (Penney, 1965) exhibit more rigidity and earlier perceptual closure (I S Cohen, 1961, Smock, 1958), and evince less preference for novel toys (Mendel, 1965)

These experiments could defensibly illustrate the following facts about the nature of neurotic anxiety and its effect on learning (a) that an actual threat to the individual apart from his own impaired self-esteem is the precipitating factor, (b) that the most effective threat is a new adjustive situation requiring improvisation since it hits at the very core of impaired self esteem (when adjustive situations become routine and familiar they are no longer threatening), (c) that the anxiety response is disproportionate to the objective danger of the threat but not to the *actual* degree of threat experienced, and (d) that the major source of threat in neurotic anxiety lies in impaired self-esteem

### *Effect of Anxiety on School Achievement*

As could be reasonably anticipated, the effect of anxiety on school achievement is comparable to its effect on learning, except that on a long term basis its disruptive influence is much less intense School achievement tasks, after all, tend to lose their threatening implications as students gain experience in coping with them At the elementary school level, anxiety generally depresses scholastic achievement (Cowen, Zax, Klein, Izzo, and Trost, 1965, Feldhusen and Klausmeier, 1962, Lunneborg, 1964, Reese, 1961, Sarason, Hill, and Zimbardo, 1964) In high school, as the motivational effects of anxiety become stronger relative to its disruptive effects, the negative correlation between anxiety and academic achievement decreases, particularly in boys, it is either weaker or entirely absent when grades are used as an index of achievement (Sarason, 1961, 1963, Walter, Denzler, and Sarason, 1964) This weak negative or zero correlation also prevails at the college level (Alpert and Haber, 1960, Grooms and Endler, 1960, Spielberger and Katzenmeyer, 1959), or is replaced by a positive relationship between anxiety and academic achievement (Lundin and Sawyer, 1965), especially among academically superior students (Spielberger, 1962) In highly structured learning tasks such as programmed instruction, a positive relationship has been reported between anxiety and achievement (Kight and Sassenrath, 1966, Traweek, 1964) This finding is consistent with the fact that anxious pupils, particularly when compulsive, do much better in highly structured learning situations where novelty and the need for improvisation are minimal

### *Anxiety and Intelligence*

Research evidence indicates almost uniformly that there is a low but significant negative correlation between anxiety and intelligence (Cowen, Zax, Klein, Izzo, and Trost, 1965, Feldhusen and Klausmeier, 1962, Feldhusen, Denny, and Condon, 1965, Hafner and Kaplan, 1959, Sarason, Hill, and Zimbardo, 1964, Spencer, 1957, Spielberger and Katzenmeyer, 1959, Wrightsman, 1962) These findings are consistent with the previously discussed inverse relationship between anxiety and novel problem solving, they suggest that in a threatening test situation, the negative effects of anxiety on complex learning tasks overshadows its positive motivational effects on test performance Another equally plausible explanation of this relationship is that the low IQ individual may feel generally anxious as a result of his inferior school achievement. A less likely interpretation is that anxiety may actually depress the development of intelligence rather than merely depress performance on an intelligence test

## Dogmatism and Authoritarianism

Dogmatism, as pointed out above, is both an aspect of cognitive style and an affective social personality trait. It is self-evidently related to the formation of beliefs and value judgments, inhibits problem solving and synthetic thinking, and is positively correlated with anxiety (Fillenbaum and Jackman, 1961, Rokeach, 1960) Some of its more important compo nents according to M Rokeach (1960), include (a) closedmindedness—un willingness to examine new evidence after an opinion is formed, a tendency summarily to dismiss evidence or logic in conflict with one's position, (b) a tendency to view controversial issues in terms of blacks and whites, (c) opinionation—a tendency to form strong beliefs, highly resistive to change, on the basis of equivocal evidence (d) a tendency to reject other persons because of their beliefs, (e) a tendency to isolate contradictory beliefs in logic tight compartments, and (f) intolerance for ambiguity—a need for early closure in reaching conclusions about complex issues

Authoritarianism is a related personality trait that is characterized by orthodoxy, veneration of traditional beliefs, and a tendency to overconform uncritically to the views of authority figures (Adorno, Frenkel Brunswick, Levenson, and Sanford, 1950) The authoritarian personality tends to be ethnocentric, prejudiced against minority groups and intolerant of ambi guity (Adorno, Frenkel Brunswick, Levenson, and Sanford, 1950), and he is found more commonly in lower class and low occupation groups (Adorno, Frenkel Brunswick, Levenson, and Sanford, 1950, Livson and Nichols, 1957) Students making high scores on scales of authoritarianism are more likely to structure novel stimuli in rigid fashion, to reach closure more quickly, and to change their attitudes in response to prestige suggestion (Duncan, Signori, and Rempel 1964 Harvey, 1963, Wright and Harvey, 1965)

## Personality Adjustment and School Achievement

Several lines of evidence indicate that poor personality adjustment is associated with inferior academic achievement Both teachers ratings of adjustment (Ausubel, Balthazar, Rosenthal, Blackman, Schpoont, and Welkowitz, 1954b, Ullman, 1957) and scores on the California Psychological Inventory (Gough, 1964) are moderately correlated with such criteria of success in school as grade point average, completion of high school, and graduation with honors High achievers in school indicate fewer problems on the Mooney Check List (Frankel, 1960), and are characterized by such traits as high ego integration, independence, maturity, and responsiveness to cul tural pressures (d Heurle, Mellinger, and Haggard, 1959) Negative self concept in kindergarten is predictive of poor progress in reading[2] (Watten

[2] The identification of negative self concept at *kindergarten* age in this study precludes the interpretation that all of the inverse relationship between personality adjustment and academic achievement can be attributed to the negative effects of school failure on the self concepts of pupils

berg and Clifford, 1964) W B Brookover, S Thomas, and A Patterson (1964) found that positive self-concept is associated with higher achievement in four subject matter areas Academic success is correlated with realistic goal setting (Byers, 1962) and with self-confidence and clear vocational goals (Todd, Terrell, and Frank, 1962)

It is hardly surprising, of course, that personality maladjustment is negatively related to school achievement, inasmuch as all of the symptoms of such maladjustment self-evidently interfere in one way or another with the cognitive and motivational factors promoting effective long term learning First, a common complex of symptoms associated with diffuse brain damage, namely, hyperactivity, hyperirritability, distractability and emotional lability, impedes effort, attention, and persistence Second, we have already observed that, in elementary school, school achievement correlates negatively with anxiety despite the high achievement motivation characterizing this condition Third, severe withdrawal reactions obviously render any kind of long term learning impossible Fourth, exaggerated aggressiveness leads to hostility toward the teacher, uncooperativeness, and a negativistic attitude toward learning[3] Fifth, lack of self-confidence is associated with failure to try, easy discouragement, 'learning blocks,' and a tendency to withdraw from difficult situations Sixth, school achievement depends, in large measure, on such attributes of personality maturity as responsibility, executive independence, long term goals, impulse control, persistence and ability to defer gratification of hedonistic needs Lastly, both personality maladjustment and inferior school achievement are correlated with lower social class status and cultural deprivation, and hence with each other The more common signs of personality maladjustment associated with these conditions are low attention span, hyperactivity, aggressive reactions, low level of academic aspiration, and personality immaturity

Two other factors also help account for the inverse relationship between personality maladjustment and school achievement. In the first place, the cause and-effect aspect of the relationship obviously works in both directions school achievement is a determinant as well as a consequent of personality adjustment. Second, it is almost impossible to eliminate the halo effect of each variable on the other, teachers tend both to downgrade the academic achievement of poorly adjusted children, particularly if they are aggressive, inattentive, or hyperactive, and to give poor adjustment ratings to nonachieving pupils Halo effects are minimized if objective measures of achievement and adjustment are used.

[3] Aggressive, acting-out high school boys tend to perceive their parents as less loving than do well adjusted boys, and also identify less with their parents (Longstreth and Rice 1964)

## The Personality Development and Mental Health Responsibilities of the School

Most reasonable persons would agree today that the legitimate functions of the school extend beyond the development of intellectual skills and the transmission of subject matter knowledge The school also has undeniable responsibilities *with respect to mental health and personality development, simply because it is a place where children spend a good part* of their waking hours, perform much of their purposeful activity, obtain a large share of their status, and interact significantly with adults, agemates, and the demands of society By virtue of their interaction with teachers *and peers and of their participation in curricular and extracurricular school* activities, adolescents, for example, make significant strides toward emancipation from parents and the acquisition of adult personality status

Particularly during adolescence, current problems of adjustment—vocational choice, emancipation from parents, somatic deviations, relationships with peers, adults, and members of the opposite sex—are very real and important to pupils Psychologically, these developmental tasks are too urgent to be ignored Hence, education must perforce be concerned with problems youth consider to be important If young people perceive the school as uninterested in these problems, they react either by losing interest in the academic areas the school values or by feeling guilty for being preoccupied with supposedly trivial matters If current concerns are not relieved, they inevitably serve as distractions from academic responsibilities

*Hence, as long as the organizational, administrative, disciplinary, and* interpersonal aspects of the school environment inevitably affect the mental health and personality development of its future citizens, it obviously behooves society to arrange these matters as appropriately and constructively as possible Nevertheless, because the mental hygiene role of the school has been oversold and misrepresented so frequently by educational theorists, it will be worth our while to consider some of the more serious misconceptions about the mental health functions of the school

### *The Primary Responsibility of the School*

To begin with, we need to recognize that the primary and distinctive function of the school in our society is not to promote mental health and personality development but to foster intellectual growth and the assimilation of knowledge The school admittedly has important responsibilities with regard to the social, emotional, and moral aspects of the pupil s development, *but certainly these are only supplementary to those of other* socializing agents such as the home the church and the neighborhood The school s role in intellectual development however is incontrovertibly primary Furthermore much of the school s legitimate concern with interpersonal relations in the classroom does not stem merely from interest in enhancing healthful personality development as an end in itself no matter how important this objective may be It also reflects appreciation of the negative effects which an unfavorable social and emotional school climate has on academic achievement on motivation to learn and on desirable attitudes toward intellectual inquiry For example if pupils feel unhappy and resentful about the discipline and social environment of the school they will neither learn very much while they are in school nor remain much longer than they have to And if they are goaded by fear to accept uncritically the views of their teachers and to memorize materials they do not really understand they neither learn how to think for themselves nor build the foundations of a stable and usable body of knowledge

### *The Limits of Normality*

As was long true in the area of physical hygiene some educators also tend to exaggerate the seriousness and permanence of the effects on mental health of minor deviations from the norm of desirable hygienic practice There is every reason to believe however that a wide margin of safety is the rule both in physical and mental health Within fairly broad limits many different kinds of teacher personality structure and ways of relating to children are compatible with normal mental health and personality development in pupils This principle applies when either mildly undesirable classroom practices prevail over an extended period of time or when more serious deviations from optimal standards occur occasionally In general children are not nearly as fragile as we profess to believe and do not develop permanent personality disabilities from temporary exposure to interpersonal practices that fall short of what the experts currently regard as appropriate Furthermore many pupils who manifest signs of behavior disturbance in school either do so only temporarily (Harris 1960 MacFarlane Allen and Honzik 1954) or fail to show any symptoms of maladjustment at home or in the peer group

### *The Cult of Extroversion*

In education as in many other vocational fields professional leaders have succumbed to the cult of the warm outgoing amiable and extroverted personality and have tended to regard any deviation from this standard as axiomatically undesirable from a mental hygiene standpoint Formerly a pupil would be referred to the school psychologist if he was boisterous aggressive and refractory to discipline Now it is the child who is reserved contemplative and unconcerned about the opinion of his peers who arouses the clinical concern of the child guidance specialist Similarly many excellent teachers who happen to be shy and introverted are viewed *with alarm by their psychologically oriented superiors Yet there is ab*solutely no evidence that they impair their pupils mental health even though they may conceivably be less popular as individuals than their extroverted colleagues and as far as pupil popularity is concerned it has *been definitely established that this characteristic may be a grossly mis*leading index of social adjustment An ostensibly popular pupil may be little more than a stranger in his group in terms of the depth of his attachments or may be popular simply because he is docile conforming and willing to be directed and used by others (Wittenberg and Berg 1952) Contrariwise the pupil who is unpopular because of temperamental shyness or strong intellectual interests is not necessarily socially maladjusted or inevitably fated to become so (Morris Soroker and Buruss 1954)

## The Teachers Responsibility in Handling Personality Maladjustment

It is important for teachers to recognize that their responsibility in handling personality maladjustment in their pupils is at most extremely limited In the first place the origin of serious maladjustment does not typically lie in the school but rather in the home and neighborhood and sometimes in brain injury or genically determined temperamental traits Hence amelioration of the condition largely depends on factors outside the school environment and beyond the teachers control Second valid diagnosis and appropriate treatment of personality maladjustment call for qualifications that obviously extend beyond the teachers training and competence

*Available evidence indicates that teachers are not very successful in* assessing the personality make up and adjustment of their pupils They cannot predict very accurately pupils responses to questions on their hobbies interests problems and personality characteristics (Amos and Washington 1960 H L Baker 1938) their motivations and academic strivings (Ausubel 1951 Ausubel Schiff and Zeleny 1954b) their scores on objective and projective tests of adjustment (Ausubel Schiff and Zeleny 1954b) and the extent to which they are accepted by their classmates (Ausubel Schiff and Gasser 1952 Bonney 1947 Gronlund 1950) These latter perceptions become increasingly more inaccurate as pupils progress through the grades (Ausubel Schiff and Gasser 1952 Moreno 1934)

*It is not difficult to find explanations for this state of affairs Teachers* are simply not aware of the distinctive standards and values that operate in the lives of their pupils By the age of adolescence, the estrangement between children and their elders has made considerable progress and is often compounded by the outright hostility and anti adult attitudes mani fested by youth Channels of communication break down and teachers are obliged to interpret pupils behavior at face value or by their own standards and frames of reference They fall back upon interpretive biases from recol lections of their own adolescence and from norms of behavior that pertain exclusively to their own middle-class backgrounds In evaluating other aspects of the adolescent s personality or adjustment, they are also not unnaturally influenced by his conformity to the requirements of the school situation As pointed out above, halo effect accounts for some of the mod erately high correlation between high school pupils school achievement and teachers ratings of personal adjustment. Teachers also tend to over value the popularity of children with whom they have satisfactory relation ships (Bonney, 1947, Gronlund, 1950)

The implications of these findings are obvious If teachers cannot ac curately perceive the interests attitudes motivations, aspirations, and prob lems of their pupils, they will naturally be unable either to counsel them very intelligently or to adapt effectively the interpersonal climate of the school to the special personality needs of those who are maladjusted. Lack ing adequate understanding of pupil behavior, they will be unable to inter pret misbehavior, to respond adequately to it, or to institute appropriate preventive and disciplinary measures. And unfortunately, although general knowledge of child development does facilitate the understanding of *particular* pupils, it is no substitute for adequate psychological perceptive ness or sufficient intimate contact with pupils.

Ability to empathize with pupils does not, of course, obligate teachers to adopt their values, nor does it guarantee effectiveness in dealing with them Understanding is necessary but not sufficient for skilled interpersonal relationships or effectiveness in counseling, since many other abilities and personality traits that are probably uncorrelated with psychological sensi tivity (poise, self assurance, firmness leadership qualities) are necessary for translating accurate perceptions into appropriate interpersonal behavior or skill in guidance

Thus, the teacher's actual role in handling the behavior disorders lies in recognizing signs of serious maladjustment and in referring disturbed pupils to counselors, school psychologists, and psychiatrists It is important, however, that they view realistically what these "experts" can typically hope to accomplish First, it is evident that counseling and psychotherapy have been greatly oversold. The analogy of mental disease to physical disease is still quite euphemistic, since incomparably less is known about the causes, nature, and treatment of the former than about corresponding aspects of the latter. Second, many of the so-called psychological "experts" in the schools have had little more clinical training and supervised clinical experience than teachers. Lastly, even the well trained counselor, clinical psychologist, and psychiatrist frequently lack the psychological sensitivity, empathy, and perceptiveness necessary for valid personality assessment. This much is evident from the fact that when counselors use impressionistic interview and anecdotal data (in addition to grades and aptitude test scores) in predicting the academic success of pupils, their predictions become less (rather than more) accurate than predictions based on the objective measures alone (Meehl, 1954). This, of course, does not argue for the elimination of trained clinical judgment from the assessment of personality adjustment, but, rather, for the use of more sensitive criteria in selecting empathic clinicians.

Chapter 12

# GROUP AND SOCIAL FACTORS IN LEARNING

SINCE SCHOOL LEARNING TAKES PLACE in a social context, teachers must obviously be concerned with group and social factors that impinge on the learning process. As a member of a classroom group, a pupil's motivation for learning, the kinds of motivations he exhibits, his social behavior, his personality development, and certainly the values and attitudes he learns are affected by his interaction with other pupils. How then is his learning in school influenced by such group variables as working with and in the presence of agemates, cooperation and competition, conformity to group norms, relative responsiveness to peer versus adult expectations, and the social-emotional climate of the classroom? We shall also want to consider how the pupil's membership in a sex, social class, ethnic, and racial subgroup affects the motivational and attitudinal aspects of school learning. Apart from general classroom climate, the teacher's contribution to the social context in which learning occurs—his role, personality characteristics, and teaching style—will be reserved for the following chapter.

It must be appreciated at this point that many group and social factors impinging on school learning—for example, authoritarianism in the classroom, cooperation and competition, conformity and its changes with age, individual differences in orientation to group experience, the alienation of pupils from adult society, social class stratification, racial and ethnic factors, motivational aspects of cultural deprivation, and so forth—do so quite *indirectly* by affecting both the learner's degree and kind of motivation for acquiring subject matter knowledge and his mode of assimilating cultural norms and values. Their relevance for educational psychology is therefore less immediate and more tangential than that of cognitive factors, motivation, or such personality factors as anxiety and dogmatism. Nevertheless they must still be taken into account both by the teacher and by the educational psychologist in assessing all of the significant determinants of academic performance To a certain extent, also, they must first be understood as phenomena in their own right before their impact on school learning can be evaluated Hence a *minimal* background of developmental and social psychological data and discussion is presented below to serve this purpose It is not intended as complete coverage of the topics in question, or as a substitute for the more definitive treatment which these topics receive in courses in developmental and social psychology where they are quite properly considered as ends in themselves and not merely in relation to their influence on academic achievement

## Classroom Climate

Although the weight of the evidence indicates that the choice between authoritarian and democratic classroom climates in the United States has little effect on subject matter achievement (G G Stern, 1963), there is good reason to believe that it has profound effects on attitudes toward school, on general social behavior in the school, and on the learning of adult values (Ausubel, 1965b, G G Stern, 1963) It seems reasonable to suppose that as children become older in a democratic society, particularly at adolescence and beyond, authoritarian controls should be progressively liberalized to meet increasing needs for self-determination and growing capacities for self direction and self-discipline This is generally the case in most American secondary schools, but prevailing practice in many schools still falls far behind desirable standards of democratic classroom practice

In general, overt compliance is the most common response that preadolescents and adolescents make to excessive authoritarianism in the classroom, especially if they are girls and if they come from middle class homes that place a great premium upon success in school Adolescents from other backgrounds, however, may react with open aggression and hostility to teachers, with negativism, or with passive sabotage Still others may drop out of school as soon as it is legal to do so Yet even those adolescents who apparently become overtly reconciled to a continuation of an incongruously submissive childhood role probably do not really accept the authoritarianism to which they outwardly defer, but respond with suppressed resentment and variously negatively toned emotional reactions

The widespread immature attitudes of New Zealand adolescents toward authority illustrate some of the undesirable behavioral effects of an overly authoritarian secondary school regimen in a generally egalitarian society (Ausubel, 1965b) First, in public situations, New Zealanders tend to defer excessively to the opinions of authority figures and to overconform to their dictates Second, coexistent with this exaggerated public deference to au thority, particularly among university students, is a puerile species of defiance, and an irresistible impulse to reject traditional values out-of-hand, to take outrageously extreme positions, and to shock the sensibilities of conventional folk with sacrilege profanity and the desecration of revered symbols Third, because of resentment toward a discriminatory type of authoritarianism and overhabituation to external controls, many secondary-school pupils fail adequately to internalize recognized social norms and individual restraints Hence they feel quite justified in violating rules and asserting themselves when authority turns its back. Finally, the distinctive feature of adolescent misbehavior in New Zealand is simply a more exaggerated and generalized expression of anti adult feeling and puerile defiance of adult authority In its most extreme form, bodgieism, it is basically a cult of exhibitionistic nonconformity, out-of bounds loutishness, and of studiously labored rejection of adult respectability Among its multiple causes must certainly be counted widespread adolescent resentment of an inappropriately authoritarian type of discipline and subordination relative to other age groups in New Zealand society It bears some relation to the beatnik movement in the United States but occurs in a younger age group, is less intellectual in its manifestations, and is more directly aggressive rather than philosophical in its protest

Older children and adolescents also do not satisfactorily internalize values that are indoctrinated in an authoritarian fashion if the adult culture itself is organized along democratic and egalitarian lines Under these circumstances they feel unjustly treated and discriminated against, and not only do they tend to resent the authoritarian discipline that is imposed upon them, but also to conform to adult standards only under threat of external compulsion This is particularly true if they perceive that many adults do not honor these standards but, nevertheless, presume to punish them when ever they are guilty of lapses Hence, when adults preach the virtue of hard work, ambition, responsibility, and self-denial, but do not practice these virtues themselves in occupational life, children tend to emulate their example rather than their precepts They become habituated to striving and working hard under external pressure but fail adequately to internalize these values. Thus, when they finally enter the adult vocational world and the customary authoritarian demands for conscientious effort are lifted, the tenuous structure of their disciplined work habits tends to collapse in the absence of genuinely internalized needs for vocational achievement.

Experimental studies of the impact of authoritarian leadership on children s groups also point to various undesirable effects on group morale and solidarity (Lippitt, 1940) In comparison with children in democratically governed groups, pupils who are subjected to autocratic control are more aggressive, direct their aggression against scapegoat group members rather than against the group leader, and adopt more submissive, placatory, and attention demanding attitudes in dealing with the leader They also manifest less "we feeling," show less capacity for mobilizing constructive group effort in overcoming frustrating conditions, and are less capable of self disciplined work and behavior when direct supervision is removed H H Anderson (1943) obtained similar findings in studying the effects of "dominative" and "integrative" behavior by teachers

There has been, however, a strong tendency on the part of educators to overgeneralize the significance of these findings In the first place, the authoritarian leaders in the Lippitt study were hostile and unfriendly, and tended to give disruptive commands Typically, authoritarian leadership tends to be more friendly, subtle, and benevolent, and thus has less damaging effects on social behavior and group morale Second, the effects of autocratic and democratic classroom climate are relative, in part, to the personality structure of individual students Students who have a strong need for direction and organization react favorably to a directive approach and very critically to a more permissive one (Wispe, 1951) Most important of all, it is undoubtedly ethnocentric to claim that only democratic teacher pupil relationships are compatible with normal mental health and personality development Many examples of authoritarian Western cultures (for example, Germany, Italy, Switzerland) exist in which all of the indices of mental health and mature personality development compare very favorably with those prevailing in the United States Hence it is obviously not authoritarianism *itself* that has damaging mental health consequences, but rather the existence of authoritarian practices in home and school that are incongruous with the general pattern of interpersonal relations in the culture at large

Children *are* able satisfactorily to internalize adult personality traits and mature attitudes toward authority, even in an authoritarian home and school environment, providing that (a) personal, social, and working relationships among adults are similarly authoritarian, and (b) adults generally make as stringent demands on themselves as they do on young people In countries like Germany and Switzerland these latter conditions prevail, and therefore authoritarianism in home and school has few adverse effects on mental health and personality development In New Zealand and the United States, on the other hand, authoritarianism in the home and secondary school has more serious effects because it contrasts sharply with the egalitarian and generally relaxed character of vocational and social life in the adult world (Ausubel, 1965b)

In all cultures, however, even those which are generally authoritarian, there are credible grounds for supposing that an authoritarian classroom climate would generate the same effects on thinking and problem solving as does the authoritarian personality, and lead to less effective group planning, teamwork, and self direction R Spaulding (1963) found that punitive teachers emphasizing shame as a technique of control tend to inhibit pupil creativity It also seems likely that an authoritarian and punitive classroom climate would increase the anxiety level of less able and anxious pupils and make them more defensive about exposing their inadequacies

Partly as a reaction against traditional authoritarian practices a small minority of schools and teachers under the influence of ultra permissive doctrines of child rearing have instituted a laissez faire social climate in the classroom This approach permits pupils to do as they please emphasizes freedom from restraint and discipline as an end in itself strives for lack of structure and organization in school activities and conceives of frustration as an unqualified evil to be avoided at all cost Under such catch-as-catch-can conditions aggressive pupils become ruthless whereas retiring children become even more withdrawn Observation of groups in which this pattern prevails shows that it leads inevitably to confusion insecurity and keen competition for power among group members (R Cunningham 1951) Pupils fail to learn the normative demands of society and how to operate within the limits these set do not learn how to deal effectively with adults and develop unrealistic expectations of the social structure of vocational life

## Interaction among Pupils

Do pupils learn more effectively when they work individually or in groups There is no single answer to this question since it all depends on the nature of the task on whether they are working *with* or merely in the presence of others on the size and nature of the group and on whether our criterion of superiority is a group product or the individual products of the component group members

First in performing simple or routine tasks requiring little or no thinking the concomitant activity of other similar individuals seems to serve as a stimulus generating contagious behavior and competitive striving—either when pupils work by themselves in the presence of others (Mukerji 1940) or when they work in pairs (Myers Travers and Sanford 1965) This effect is comparable to the heightened rate of activity stimulated by a pace setter

Second in novel and complex problem solving tasks where obtaining a correct solution is facilitated by generating a multiplicity of alternative hypotheses (divergent thinking) group effort is apparently superior to individual effort (M Goldman 1965 Klausmeier Wiersma and Harris 1963 Lorge 1955 Marquart 1955 M E Shaw 1932 G B Watson 1928) Closer analysis however reveals that this superiority is mostly attributable to the pooling of ideas the total product of the group is not much better than the sum of the products of its component members Group effort is more effec tive, in other words, largely because it increases the possibility of having at least one person who can arrive independently at the correct solution This advantage however, is vitiated if the group is so congenial (Back, 1951 Shaw and Shaw, 1962), or if its leadership is so personal (Fiedler, 1958) that considerable group time and effort is diverted into purely social activity or pleasant conversation Also if the task requires evaluation or decision making, cooperative deliberation and the reaching of consensus is usually superior because it avoids the pitfalls of idiosyncratic or extreme judgment (Barnlund 1959) Although group support undoubtedly reduces anxiety and enhances confidence in problem solving situations, it also reduces, by the same token, individual responsibility and initiative

The cohesiveness (congeniality) of the group may also affect the outcome of its collaborative work in a problem solving situation The mere presence of congenial co workers may increase the effectiveness of cooperative effort, may enhance motivation by increasing task attractiveness, and may provide a source of mutual social reinforcement upon successful completion of the task (Lott and Lott, 1961, 1966) This, at least, appears to be the case for cohesive groups composed of high but not of low IQ individuals (Lott and Lott 1966)

Group size is another limiting factor in the group problem solving situation *In a small group each individual can make a contribution and* thereby increase his problem solving skills In a large group on the other hand, the individual s opportunity for participation is not only limited by the number of participants but also by the fact that the more aggressive group members tend to take over and monopolize the problem solving activity (Carter, Haythorn Lanzetta, and Mairowitz, 1951)

Third, if the learning product of *each* group member is used as our criterion of success in the former problem solving situation, it is evident that the less able members of the group can accomplish more than they could individually, by virtue of being stimulated by and being able to adopt the ideas and strategies of the more able pupils (Gurnee, 1962) In effect, *they enjoy the benefit of pupil tutors Thus, the gain in skill is always* greatest among low ability pupils and among pupils working with superior partners (M Goldman, 1965)

Fourth, certain tasks (for instance, the drafting of a report) requiring convergent thinking, intense concentration, and persistent attention to detail can self evidently be performed more efficiently on an individual rather than on a group basis This is obvious to anyone who has ever worked on a committee

Finally, as pointed out earlier, self paced, individualized (programmed) instruction is a much more efficient and less time-consuming method of learning the established content of a discipline than the traditional recitation or lecture-discussion approach used *in most classrooms Discussion, on* the other hand is the most effective and really the only feasible method of promoting intellectual growth with respect to the less established and more controversial aspects of subject matter It provides the best means of broadening the pupil s intellectual horizons of stimulating his thinking through cross-fertilization of clarifying his views and of measuring their cogency against the viewpoints of others Interaction with peers further more helps the pupil overcome both his egocentricity and his childhood perception of adults as the absolute source of truth and wisdom with regard to all value judgments He learns the extent to which both his ideas and those of the teacher represent idiosyncratic positions along a broad spectrum of opinion whose validity is indeterminable

### *Individual Orientation to Group Experience*

A brief word might be said at this point about pupils differential per sonality orientations toward group experience The child s idiosyncratic manner of relating to significant persons in the family setting has ample opportunity to become solidified long before he is ever permitted to venture unmonitored from the home It is hardly surprising therefore that this approach to interpersonal experience with his earliest socializers should be generalized to other kinds of social situations To the satellizing child the peer group provides derived status in much the same way as the parent except that the status-giving authority resides in a corporate body of which he himself is part By relating to it he obtains the same spontaneous we feeling that he experiences in the family group

The nonsatellizer on the other hand cannot assume an internalized position of self subserviency in relation to the group The field of intra group relations like the home is no place for we feeling' it is just an other arena in which he contends for primary status prestige power and self aggrandizement. He does not subordinate himself to group interests or experience spontaneous satisfaction in gregarious activity Every social move is carefully deliberated for the possible advantages that may accrue from it and the currency of social interchange is supplied by the synthetic manu facture of attitudes remarks and behavior which can be construed as con ventionally appropriate for the specifications of a given situation He is quite capable of course of harvesting vicarious status from identification with prestigeful membership or reference groups but since no subservience of self is required, it bears little resemblance to the derived status of satel lizers The prestige of family club college nationality etc. is incorporated merely as a gratuitous form of ego-enhancement or as a springboard for the realization of personal ambitions As already pointed out the non satellizing orientation to group experience tends on a normative basis in creasingly to characterize the maturing individual as he approaches adult

Conformity is a self consistent normally distributed personality trait with a fair amount of generality from one situation to another (Vaughan 1964) The tendency to conform to group opinion is greater the more attractive group membership is perceived to be (Kinoshita 1964) In general particularly during the adolescent period girls are more conforming than boys (Tuma and Livson 1960) and as one might anticipate from the data on authoritarianism conforming tendencies are greater among lower class (Tuma and Livson 1960) and religious (Fisher 1964) adolescents

Conformity to group standards depends for the most part on the internalization of shared expectations and of a set of norms which the group members themselves help to formulate overt pressures and sheer physical force are relatively minor factors (Sherif and Sherif 1964)

> The group norms that are most binding and most consequential in the members scheme of concerns are the ones that regulate matters of solidarity among members and that set standards of conduct in the very spheres of motivational promptings that [bring] them together The most tightly knit groups observed [are] those whose members [have] fewest stable ties with other groups and institutions hence whose belonging [is] highly important to them (Sherif and Sherif 1964 pp 250 268)

Group solidarity is therefore highest in low rank neighborhoods In all groups however the range of acceptable behavior exhibits least latitude for the leader and high status members In matters related to the maintenance of group activities and of loyalty the leader is expected to be the exemplar (Sherif and Sherif 1964 179)

It is necessary for two important reasons that the peer group demand considerable conformity from its members First no institution especially if it has status-giving functions can exist for any length of time without due regard by its members for uniform regular and predictable adherence to a set of avowed values and traditions Hence in its efforts to establish a new and distinctive subculture and to evolve a unique set of criteria for the determination of status and prestige the peer group must do everything in its power to set itself off as recognizably distinct and separate from the adult society which refuses it membership If this distinctiveness is to be actually attained widespread nonconformity obviously cannot be tolerated Second conformity is also essential to maintain the group solidarity that is necessary to offer effective and organized resistance to the encroachments of adult authority If an appeal to precedent or to a *prevailing* standard of adolescent behavior is to be the basis for exacting privileges and concessions from adults a solid and united front with a minimum of deviancy must be presented to the world

Because of the adolescent s marginality of status the peer group is in an excellent position to demand conformity from him as the price of its acceptance. Much more so than the child or adult, he is desperately dependent on the peer group for whatever status and security he is able to achieve during these hectic years of transition. The group implicitly and explicitly makes clear to him that it expects conformity to its standards, interests, activities, and value systems in return for the moral support, the feeling of belongingness, the attributed status, and the opportunities for earned status that it extends to him, and he in turn, like any person with marginal status, is excessively sensitive to the threat of forfeiting what little status he enjoys as a result of incurring the disapproval of those on whom he is dependent. Thus, to allay the anxiety from the threat of disapproval, he tends to conform more than is objectively necessary to retain group acceptance or to avoid censure and reprisal.

After he wins an assured place for himself in the group, still other factors reinforce conforming tendencies. He learns that group approval brings a welcome reprieve from anxiety and uncertainty. If his group approves, he can feel absolutely certain of the correctness of his position. Feelings of loyalty, belongingness, and indebtedness also influence him to render conformity automatically as a voluntarily assumed obligation. Finally, if these implicit group pressures and internalized restraints and dispositions of the individual are insufficient to keep him in line, explicit sanctions are imposed. Depending on the seriousness of the offense and the functions and nature of the group, the punishment may vary from ridicule, censure, and rebuff to physical chastisement and complete ostracism.

It is clear, therefore, that the adolescent's marginality of status makes him prone to overvalue the importance of conformity and to exaggerate the degree of conformity required for acceptance by the peer group. Sociometric studies show that adolescents consistently *over*estimate the status of popular individuals and correspondingly *under*estimate the extent to which deviant or low prestige persons are accepted by the group (Ausubel, 1955). Some evidence also points to the conclusion that apparent disregard for the group's approval tends to enhance the individual's sociometric status by making him appear above the need for currying favor with others (Newstetter, Feldstein, and Newcomb, 1938). Hence, many perfectly safe opportunities for the expression of individuality are lost.

In the light of the structural properties of their peer group and of prevailing overconforming trends in the culture at large, it is small wonder that American adolescents tend to overvalue conformity and expediency and to avoid independent thinking and ideological commitment. In the adolescent peer culture of Prairie City, R. J. Havighurst and H. Taba (1949, p. 87) found that "accepting familiar stereotypes [was] one outstanding characteristic of most beliefs. . . . Individual positions deviating from the generally accepted code [were] feared and shunned. This [was] shown by hesitancy in expressing opinions contrary to common beliefs, and by approving wrong behavior if most of one s associates [were] involved in the act There [was] a marked tendency to subordinate individually held positions to both adult and peer group opinion even when one s own positions [were] considered morally right Other expressions of these same conforming tendencies include the approved attitude of coolness toward and emotional detachment from moral and controversial issues and the low status accorded intellectuality and intellectual status in most peer groups

## *Qualifications and Positive Aspects*

Lest we tend to take too dim a view of these seemingly negative features of adolescent conformity it is important that we now consider some of the more positive aspects of this phenomenon The transfer of allegiances from parental to peer group standards constitutes more than an exchange of one type of slavish conformity for another By providing a new source of values and standards as well as experience in behaving as a sovereign person the peer group plays an important role in devaluing parents and promoting desatellization In switching his basic loyalties to the peer group the adolescent takes great strides toward emancipation He finds a new source of basic security to supplant the emotional anchorage to parents that had hitherto kept him confined within the dependent walls of childhood By vesting in his peers the authority to set standards he affirms his *own* right to self determination since he is patently no different from them No longer need he implicitly subscribe to the belief that only parents and adults can determine what is right The peer group also serves as a bulwark of strength in combating authority By pooling their resistance in groups and throwing up barriers of one kind or another against adult interference adolescents manage to exclude adults and protect themselves from the coercions that [adults] are prone to use (Tryon 1944 p 220)

The peer group s desatellizing influence also carries over into the sphere of ideas and moral values Its norms provide the adolescent with a new and stable frame of reference for moral judgment and conduct It furnishes relief from uncertainty indecision guilt and anxiety about proper ways of thinking feeling and behaving Because the peer group is never dignified by the same halo of sanctity surrounding parents the adolescent can experiment more freely with functional concepts of moral law and with a more impersonal and logical approach to value judgments To be sure full exploitation of this new active independent and critical approach to moral values is obviously limited by his marginal status and his need to conform to peer group norms The difference however is that now he conforms to external standards because he consciously recognizes the *expediency* of so doing rather than because he *implicitly* accepts their validity

Finally the dreary picture of adolescent conformity must be qualified by certain limiting factors In the first place its existence tends to be restricted to the particular developmental requirements of the adolescent period that induce it *One of the surest signs of approaching adulthood is* a resurgence in the legitimacy of deviancy Second along with their conforming tendencies adolescents display a concomitant urge to be unique to achieve individuality and separateness After the young adolescent has submerged himself in the group to the point where he cannot be criticized for non conformity he then proceeds to gain recognition for himself as an individual (Tryon 1944 p 223) He must be careful however to keep his urge for uniqueness and creativity within the narrow framework of acceptability recognized by the group Lastly as we know from the history of innumerable youth movements there is among many adolescents a vigorous strain of exuberant idealism and impatient dissatisfaction with many outmoded traditions and features of contemporary life This aspect of adolescent personality when channelled intelligently constitutes a most strategic means for effecting social change

## *Conformity and Individuality*
## *A Prescription for Adolescents*

Where do all of these developmental and cultural considerations regarding conformity and individuality leave us in proposing a feasible and morally defensible prescription for adolescents?

The crucial role of the peer group as a socializing agency and as a source of earned and attributed status counsels a certain minimal degree of deference to its standards during the self limited period when such an exaggerated premium is placed on the value of conformity During adolescence deviants are not in an enviable position In varying degrees they all face social ridicule abuse and isolation The fortunate ones achieve some measure of status and security by forming warm attachments to agemates of their own kind Sometimes a sympathetic adult friend or teacher will offer them affection direction and encouragement Often however they are left to flounder uncertainly to drift further and further away from group living to develop feelings of anxiety and inferiority to withdraw deeper and deeper into themselves or into a compensatory world of unreality

As far as the wider community is concerned the adolescent should be encouraged to adjust satisfactorily to the kind of world that currently exists not the kind adults wish existed but as yet have been unable to create Even while endeavoring to change them it is necessary to recognize established laws and customs irrational or otherwise (Partridge 1947) This does not imply that the status quo must be implicitly accepted for what it is but rather that a mature attitude toward social change be adopted, an attitude that does not 'encourage the adolescent to batter his head against the wall of custom simply because these customs are inconsistent'

However, this minimal and desirable degree of conformity to peer group standards and social custom is still a far cry from advocating a policy of hunting with the hounds Those who counsel adolescents would be remiss in their responsibility if they failed to appreciate the importance of nonconformity for the optimal differentiation of personality structure, for self realization, and for the development of moral courage and the ability to stand alone without group support Counselors must also be sensitive to individual differences in the need to conform The highly self assertive teen ager, for example, can only restrain his individuality to a point, and the introvert inevitably draws a line beyond which he refuses to participate in exhibitionistic activities The adolescent who has a highly developed set of moral or religious convictions may refuse to condone the practices of his group Other individuals may have all absorbing interests that are regarded with scorn by their agemates Finally, as has already been pointed out, the mental hygiene dangers of nonconformity and social unpopularity have been vastly exaggerated Even the peer group tolerates much more deviancy than the adolescent s anxiety and marginality of status lead him to believe

### Adult versus Peer Group Norms

It is impossible for anyone to teach in a secondary school or college for any length of time without becoming aware of the fact that a distinctive adolescent subculture exists, and that the values of this subculture are partly at variance with those of the adult community This alienation is a source of concern for the school because it extends beyond such peripheral matters as dress and language and tends to be focused on the value of academic achievement Adolescents accept scholastic achievement as necessary for college entrance and for the middle-class rewards of managerial and professional status, but they do not typically regard it as a legitimate basis for high status in the peer group or as a value worth striving for in its own right (Coleman, 1961, J B Marks, 1951) What are some of the origins of this adult youth alienation?

Adolescents in our culture, naturally, have the same needs for greater earned status and volitional independence that adolescents have in more primitive and traditional cultures But the greater complexity of our technological society necessitates an extended period of education and economic dependence on parents, prolonged vocational training, and the postponement of marriage well beyond the age of sexual maturity Under these circumstances, the adolescent cannot experience any *real* volitional indepen dence in the *adult* sense of the term, and can obviously acquire only a token earned status outside the mainstream of the adult culture He not only resents his exclusion from adult spheres of independence and status-giving activities, but also tends to resent such adult-controlled training institutions as the home, the school, and various youth organizations because they conduct their training functions entirely apart from any opportunity for him to exercise volitional independence, or to acquire earned status within the context of the adut culture Hence, he is alienated from adult status-giving activities and from adult training institutions, and, accordingly, from adult standards as well

This alienation from adult society, coupled with the accompanying resentment and prolonged frustration of his needs for adult volitional independence and adult earned status, has two serious consequences namely, the generation of aggressive anti adult attitudes and the compensatory formation of distinctive peer groups with distinctive standards, status-giving activities, and training functions of their own The aggressive anti adult orientation not only promotes further retaliatory rejection of adult standards, but also makes it more difficult for adolescents to identify with adults, to obtain any attributed status from such identification, and currently to accept adult values implicitly The formation of peer groups, on the other hand, increases the existing adult youth alienation Precisely how it does these things deserves more detailed scrutiny

### *The Role of the Peer Group in Adult-Youth Alienation*

Because all adolescents are in the same boat, so to speak, because they share the same deprivation of their needs for adult status and independence, the same alienation from adult society, the same resentments, and the same anti adult attitudes, because they feel they are not wanted do not belong, and are excluded from the larger scheme of things, they reach out toward each other for mutual support and for providing in concert the things that they want but cannot get *individually* (Sherif and Sherif, 1964)

Thus since the modern urban community is unable to provide teenagers with the kind of earned status, volitional independence, and training in social skills that they desire, the adolescent peer group is constituted to gratify, in part these crucial needs. It is the only cultural institution in which their position is not marginal, in which they are offered earned status, independence, and social identity among a group of equals and in which their *own* activities and concerns reign supreme The peer group is also the major training institution for adolescents in our society It is in the peer group that by *doing* they learn about the social processes of our culture They clarify their sex roles by acting and being responded to, they learn competition, cooperation, social skills values, and purposes by sharing the common life' (Tryon, 1944) The peer group provides regularized media and occasions for adolescents to gratify their newly acquired desires for increased social contact with the opposite sex, as well as a set of norms governing adolescent sex behavior

By virtue of performing these essential functions, the peer group also displaces parents as the major source of attributed status during adolescence By identifying with and acquiring acceptance in the group, by subordinating himself to group interests and by making himself dependent on group approval, the adolescent gains a measure of intrinsic self esteem that is independent of his achievement or relative status in the group This ' we feeling furnishes security and belongingness, and is a powerful ego-support and basis of loyalty to group norms

How does all of this increase adult youth alienation? In the first place, the adolescent s very membership in a distinctive peer group, with its own status-giving activities, standards and training functions, puts him in a *separate* subculture apart from adult society Second, since the peer group is composed of *his* kind of people and since he is largely dependent on it for his volitional independence for his earned and attributed status, for his sense of belongingness and for his opportunities to acquire social skills and practice his sex role, he accordingly tends to assimilate its standards As he becomes progressively more responsive to its approval and disapproval, he becomes increasingly more indifferent to adult norms and values, to adult suggestion and to adult approval and disapproval Lastly, the peer group's exaggerated needs for rigid conformity to its norms, as well as its power to exact conformity from its members in return for its unique ability to satisfy their needs further accentuate the adolescent s alienation from adult society

But adult youth alienation is also not an all-or none matter That is, operating simultaneously with the various factors causing adult youth alien ation in varying degrees, there are also two general factors within each adolescent that maintain or increase his identification with adult society One of these factors stems from his ultimate aspirations for the future, the other is a legacy from his childhood Both serve to counteract the severity of his anti adult attitudes.

Thus, we must not lose sight of the fact that at the same time that adolescents particularly those from middle class backgrounds, are alienated from adult standards and preoccupied with achieving *vicarious* forms of adult status and independence in the peer group, they are *simultaneously* engaged in and intensely concerned with, educational and other pursuits that serve as stepping stones to *genuine* adult status and independence and to full membership in adult society Their *ultimate* goals are *not* high status in the peer group—that is, the distinction of being the best dancer, the most prestigeful athlete, the most successful faddist, the most popular and most frequently dated girl, the most daring drag racer, the most shockingly sophisticated or anti-adult person in the crowd—but rather, well paying professional or managerial jobs, financial security, a comfortable home in the suburbs, marriage and a family. They also realize that attainment of these goals requires long-term striving, self-denial, postponement of immediate hedonistic gratifications, the approval of persons in authority, restraint of aggressive impulses, and avoidance of an unsavory or delinquent reputation. Furthermore, the assimilation of new peer group values does not by any means imply complete repudiation of previously assimilated adult values.

Thus, it greatly overstates the case to claim that adolescents are entirely oblivious of adult approval, that they completely reject adult values, standards, and aspirations, and that they manifest no feelings of moral obligation to abide by earlier assimilated norms of conduct. This much is clearly evident when we pause to consider that one of the principal functions of the peer group, in addition to providing its own distinctive set of standards, is to transmit from one generation to the next the appropriate social class values, aspirations, motivational patterns, and character traits that adolescents are often unwilling to accept from parents and teachers, but *are* willing to accept from their agemates. It is easy, therefore, to exaggerate the existing degree of adult-youth alienation. As a matter of fact, both parties tend to perceive it as greater than it actually is (Hess and Goldblatt, 1957). Indeed, where conditions are propitious, the norms of the peer group include the same intellectual concerns and excitement that prevail among the college faculty (Newcomb, 1962).

It must be admitted, however, that the progressive moral deterioration characterizing our culture since World War II has tended to undermine the counterbalancing effect of these two factors (aspirations for genuine adult status and previously assimilated adult values) on adult-youth alienation. First, since the adolescent preceives adults as being able to "get ahead" without fully exemplifying the traditional middle-class virtues, he is naturally led to believe that (a) he too can achieve the adult status and independence he craves without thoroughly acquiring these same virtues himself, and (b) adults are not really concerned whether or not he acquires these virtues. Thus, he is not as highly motivated as pre-war adolescents were either to develop such traits as self-restraint, willingness to work hard, a sense of responsibility, impulse control, self-denial, personal integrity, and respect for the rights and property of others, or to seek adult approval for so doing. Further, the middle-class peer group, which has the responsibility for transmitting middle-class standards to its members, can transmit only those standards that *actually* exist. Second, the adolescent's realization that adults do not actually live up to the standards that he had implicitly accepted in childhood as axiomatically right and proper, tends to undermine his implicit belief in these standards and in his feelings of obligation to abide by them When children become sufficiently mature to interpret adult behavior for what it actually is, they are impressed more by example than by precept Lastly, the adolescent s awareness of the grievous lack of moral courage in the adult world and of the premium that adults place on con formity and expediency furnishes him with a very poor model for holding fast to his moral convictions in the face of group pressure

## Social Sex Role and the School

The quite different social sex roles of boys and girls at all age levels have important effects on their respective adaptations to the school environ ment By virtue of their differential training in the home, girls find it much easier than boys to adjust to the demands of the elementary school We have already observed that they are more intrinsically accepted by parents, satellize more, identify more strongly with authority figures, have less in sistent needs for independence, earned status, and emancipation from the home, and are more habituated from the very beginning to docility, sedateness, conformity to social expectations, and restraint of overt physical ag gression It is hardly surprising, therefore, that boys find it correspondingly more difficult to identify with the school, with the teacher, and with classroom activities Girls play school ' as readily as they play "house," whereas any normally robust boy would not be caught dead playing either game.

It is not only that most elementary school teachers are women, but also that feminine values prevail in the school with respect to what is taught and the kind of behavior that is expected and approved propriety, obedience, decorum, cleanliness, tidiness, submissiveness, modesty, paying attention to what one is told, remembering, facility in handling verbal symbols, and the control of fidgetiness, curiosity, and aggressiveness Girls also receive much more approval and considerably less scolding and reproval from teachers (Meyer and Thompson, 1956) In terms of cultural expectations and peer group norms, success in school is much more appropriate for the female than for the male sex role in elementary and junior high school At this age level the higher achievement motivation of girls is largely a reflection of their greater desire for approval from authority figures and for the vicarious status that this confers It is not at all surprising, therefore, that boys furnish a disproportionate share of the nonreaders, the underachievers, the truants, the behavior problems, the inattentive, and the drop-outs

Beginning in middle adolescence, however, cultural expectations change radically Academic achievement becomes a more acceptable male virtue and, accordingly, the achievement gap between boys and girls begins to close Boys with low intrinsic self esteem and high anxiety seek more than do their female counterparts to find compensatory ego-enhancement and anxiety reduction in school achievement, and gifted boys tend to maintain their high IQ s better in late adolescence and adulthood

## Social Class Stratification and Education

The social class membership of a pupil has important implications for his school achievement, his aspirations for academic success, his achievement motivation, and his attitudes toward school It is true, however, that social class differences in these areas are becoming increasingly less distinct now as college education is becoming more available to and prevalent among lower-class groups (Havighurst and Neugarten, 1962) Nevertheless, there is still a moderately high relationship between socioeconomic status and school achievement (Havighurst and Breese, 1947, Havighurst and Janke, 1944, Janke and Havighurst, 1945, Pierce Jones, 1959a and b), and by the time pupils reach junior high school age this relationship is greater than that between IQ and achievement (Kahl, 1957) But it is important to note that the characteristic impact of social class membership on school achievement does *not* prevail among high ability sixth graders (R L Curry, 1962), after students enter college (Washburne, 1959), or in upwardly mobile populations (Udry, 1960) Apparently, the limiting effects of social class conditioning cease to operate as fully beyond certain critical ability and achievement levels Once students exceed these levels, they seem to be influenced more by the new student subculture with which they identify than by their social class origins The difficulty for lower class pupils, of course, lies in entering college in the first place Typically, because of either financial or motivational reasons, high school graduation marks the terminal point in the educational careers of most intellectually able lower class youth (Havighurst and Neugarten, 1962)

Recent research (Ausubel, 1965a, Hanson, 1965, Sherif and Sherif, 1964) has made it clear that youth of all socioeconomic ranks has assimilated the scholastic and vocational aspirations associated with material affluence in modern Western society It is not the appropriate aspirations that are lacking therefore, but rather those factors that are necessary for their implementation, namely, underlying needs and motivations for achievement, supportive personality traits, and perceived pressures and opportunities for academic and occupational success (Ausubel, 1965a, Rosen, 1964) In the first place, lower class parents do not place the same value that middle class parents do on education, financial independence, social recognition, and vocational success Hence, they do not *really* encourage, to the same extent the implementation of these aspirations by voicing appropriate expecta tions, making unequivocal demands, dispensing suitable rewards and punishments, and insisting on the development of the necessary supportive traits (Ausubel, 1965a)

Second, since lower-class adolescents are understandably dubious about the attainability of the promised rewards of striving and self-denial for persons of their status, they do not develop the same internalized needs for vocational achievement and prestige, and thus see less point in developing to the same degree as their middle-class contemporaries the supportive middle-class personality traits necessary for the achievement of academic and vocational success (A. Davis 1943) These supportive traits include habits of initiative and responsibility and the "deferred gratification pattern" of hard work, renunciation of immediate pleasures, long range striving, impulse control, thrift, orderliness, punctuality, restraint of sexual and aggressive urges, and willingness to undergo prolonged vocational preparation (A Davis, 1943, Havighurst and Taba, 1949, Schneider and Lysgaard, 1953)

It is hardly surprising therefore, that lower-class children are less interested in reading than are middle-class children, take their school work less seriously, and are less willing to spend the years of their youth in school in order to gain higher prestige and social rewards as adults Lacking the strong ego-involvement which middle-class pupils bring to school work and which preserves the attractiveness of academic tasks despite failure experience, they more quickly lose interest in school if they are unsuccessful

Lower and middle-class adolescents differ markedly both in their social value systems and in their vocational interests Middle-class youths and their parents are more concerned with community service, self realization, altruistic values, and internalized standards of conduct (Kahn, 1959, Stefflre, 1959), and prefer demanding, responsible, and prestigeful occupational pursuits (Pierce Jones, 1959a and b, Sewell, Haller, and Strauss, 1957) They also make higher vocational interest scores in the literary, esthetic, persuasive, scientific, and business areas than do lower-class adolescents The latter adolescents and their parents, on the other hand, place greater stress on such values as money, security, respectability, obedience, and conformity to authority, and tend to prefer agricultural, mechanical, domestic service, and clerical pursuits. In the school environment they respond more than middle-class pupils do to such learning incentives as praise and material rewards (Terrell, Durkin, and Wiesley, 1959, Zigler and de Labry, 1965, Zigler and Kanzer, 1962)

The working class mother s desire for unquestioned domination of her offspring, her preference for harsh, punitive, and suppressive forms of control, and her tendency to maintain considerable social and emotional distance between herself and her children are probably responsible, in part, for the greater prevalence of the authoritarian personality syndrome in lower than in middle-class children (Dickens and Hobart, 1959, I Hart, 1957, Lipset, 1959) Lower-class children tend to develop ambivalent attitudes toward authority figures and to cope with this ambivalence by making an exaggerated show of overt, implicit compliance, by maintaining formally appropriate social distance, and by interacting with these figures on the basis of formalized role attributes rather than as persons Their underlying hostility and resentment toward this arbitrary and often unfair authority is later expressed in such displaced forms as scapegoating, prejudice, extremist political and religious behavior, ethnocentrism, and delinquency (Dickens and Hobart, 1959, Hart, 1957, Lipset, 1959) They are coerced in school by the norms of their peer group against accepting the teacher's authority, seeking her approval, or entering into a satellizing relationship with her.

### *Social Class Bias of the School*

Most teachers in American schools have middle-class backgrounds But even if they do originate from other social class environments, they still tend to identify with the school's implicit mission of encouraging the development of middle-class values Thus, quite apart from the issue of whether this mission is appropriate and desirable for our culture, teachers find it difficult to understand the goals, values, and behavior of pupils from other social class backgrounds Normal ethnocentric bias predisposes them to believe that their own class values are self-evidently true and proper, and that deviations therefrom necessarily reflect waywardness On the other hand, since middle-class boys and girls behave in accordance with their expectations and accept the standards of the school, teachers are usually as prejudiced in their favor as they are prejudiced against children from other social strata.

Understanding the background and values of lower-class children does not, of course, imply acceptance of their attitudes and behavior when these are in conflict with the objectives and standards of the school It merely implies sufficient awareness of relevant background factors to make possible intelligent interpretation of the behavior of lower-class pupils and the avoidance of discriminatory attitudes and practices toward them

In addition to their natural inclinations to reward conformity to middle class ideology, teachers are influenced by other pressures, both explicit and implicit, in giving preferential treatment to pupils whose families enjoy high social status Middle and upper-class parents are active in civic and school affairs, members of school boards, and leaders in parent teacher associations Even if no explicit pressures are exerted, teachers and school administrators, knowing on what side their bread is buttered, are disposed to see things their way Teachers are also intimidated somewhat from taking action against refractory but popular members of leading student cliques who, when supported by their cliquemates, may be surprisingly rebellious

(Hollingshead, 1949) Under such circumstances, many teachers are reluctant to force a showdown that would provoke the enmity of pupils who are influential in their own right as well as through the position of their parents

The organization of the high school also tends to favor the retention of middle-class pupils and the earlier dropping out of lower-class pupils A disproportionate number of the latter are placed in slow learning sections— not only on the basis of low ability and motivation, but also, more informally, because of their social background (Hollingshead, 1949, Havighurst and Neugarten, 1962) Similarly, a disproportionate percentage of lower-class pupils are found in the vocational commercial, and general high school curriculums rather than in the college preparatory curriculum Thus, as a result of being typed and stigmatized as members of these low prestige groups, and of enjoying relatively low scholastic morale lower-class pupils are more disposed to drop out of school

The values of the dominant peer group in high school are predominantly based upon middle class norms and standards, chief of which is acceptance of the importance of getting good grades (Havighurst and Taba, 1949) Middle class adolescents participate more in extra curricular activities and occupy the choice elective and activity positions (Havighurst and Taba, 1949, Hollingshead, 1949, H P Smith, 1945), and evidence suggests that pupils whose behavior conforms best to the extracurricular norms and expectations of the school also do better academically (Weinberg, 1964) More important, perhaps, are the subtle and intangible barriers to participation in the more intimate crowds and cliques, very little crossing of social class lines occurs in clique organization (Hollingshead, 1949) Boys and girls from lower social class strata bitterly resent the patronizing and condescending attitudes of their more fortunate contemporaries They feel snubbed, unwanted, and left out of things When this situation becomes too intolerable it undoubtedly influences their decision to leave school (Havighurst and Taba, 1949, Hollingshead, 1949, Johnson and Legg, 1944)

## Racial Factors in Education

All of the foregoing properties of the lower class environment also apply to the segregated Negro community Most authorities on Negro family life agree that well over 50 percent of Negro families live at the very lowest level of the lower-class standard (M C Hill, 1957) In addition, however, Negro families are characterized by a disproportionate number of illegal and loosely connected unions (M C Hill, 1957) Illegitimacy is a very common phenomenon and is associated with relatively little social stigma in the Negro community (Cavan, 1959)

Negro families are much more unstable than comparable lower-class white families Homes are more likely to be broken, fathers are more frequently absent, and a matriarchal and negative family atmosphere more commonly prevails (Dai, 1949, Deutsch, and others, 1956, M C Hill, 1957) Thus, the lower class Negro child is frequently denied the benefits of biparental affection and upbringing, he is often raised by his grandmother or older sister while his mother works to support the family deserted by the father (Deutsch, and others, 1956) One consequence of the matriarchal family climate is an open preference for girls Boys frequently attempt to adjust to this situation by adopting feminine traits and mannerisms (Dai, 1949)

Negro family life is even more authoritarian in nature than is that of the lower social class generally 'Children are expected to be obedient and submissive" (M C Hill, 1957), and insubordination is suppressed by harsh and often brutal physical punishment (Dai, 1949, M C Hill, 1957) 'Southern Negro culture teaches obedience and respect for authority as a main spring of survival' (Greenberg and Fane, 1959) Surveys of high school and college students show that authoritarian attitudes are more prevalent among Negroes at all grade levels (Greenberg, Chase, and Cannon, 1957, Greenberg and Fane, 1959, Smith and Prothro, 1957)

Being a Negro also has many other implications for the ego development of young children that are not inherent in lower class membership The Negro child inherits an inferior caste status and almost inevitably acquires the negative self-esteem that is a realistic ego reflection of such status Through personal slights, blocked opportunities, and unpleasant contacts with white persons and with institutionalized symbols of race inferiority (segregated schools, neighborhoods, amusement areas)—and more indirectly through the mass media and the reactions of his own family—he gradually becomes aware of the social significance of racial membership (Goff, 1949) The Negro child perceives himself as an object of derision and disparagement, as socially rejected by the prestigeful elements of society, and as unworthy of succorance and affection (Deutsch, and others, 1956), and having no compelling reasons for not accepting this officially sanctioned negative evaluation of himself, he develops a deeply ingrained negative self image (V W Bernard, 1958, Wertham, 1952)

In addition to suffering ego deflation through awareness of his inferior status in society, the Negro child finds it more difficult to satellize and is denied much of the self esteem advantages of satellization The derived status that is the principal source of children s self esteem in all cultures is largely discounted in his case since he can satellize only in relation to superordinate individuals or groups who themselves possess an inferior and degraded status Satellization under such conditions not only confers a very limited amount of derived status but also has deflationary implications for self esteem We can understand, therefore, why young Negro children resist identifying with their own racial group why they seek to shed their identities (Deutsch, and others 1956) why they more frequently choose white than Negro playmates (Stevenson and Stewart, 1958) why they prefer the skin color of the culturally dominant caste (Clark and Clark 1947 Goodman, 1952) and why they tend to assign negative roles to children of their own race (Stevenson and Stewart, 1958) Such tendencies persist at least into late adolescence and early adult life insofar as one can judge from the attitudes of Negro college students These students tend to reject ethnocentric and anti white ideologies and to accept authoritarian and anti Negro propositions (Steckler, 1957)

### *Educational Achievement of Negro Children*

Partly as a result of unequal educational opportunities Negro children show serious academic retardation They attend school for fewer years and, on the average learn much less than white children do (Ashmore, 1954, Bullock, 1950, Cooper 1964 Osborne 1960) One of the chief reasons for this discrepancy is the inferior education and training of Negro teachers who themselves are usually products of segregated education The inequality of educational facilities exists not only in the South but also in the urban North, where, for the most part segregation in fact prevails (Smuts, 1957) Eighty four percent of the top 10 percent of Negro graduates in one southern high school scored below the national mean on the Scholastic Aptitude Test (Bullock 1950) Thus the incentive of reaching the average level of proficiency in the group is not very stimulating for Negro children, since the mean and even the somewhat superior child in this group are still below grade level Teachers in segregated schools also tend to be overly permissive and to emphasize play skills over academic achievement, they are perceived by their pupils as evaluating them negatively and as more concerned with behavior than with school work (Deutsch and others, 1956)

Even more important perhaps as a cause of Negro educational retardation is the situation prevailing in the Negro home Many Negro parents have had little schooling themselves and hence are unable to appreciate its value. Thus they do not provide active, wholehearted support for high level academic performance by demanding conscientious study and regular attendance from their children Furthermore, because of their large families and their own meager schooling they are less able to provide help with lessons Keeping a large family of children in secondary school constitutes a heavy economic burden on Negro parents in view of their low per capita income and the substantial hidden costs of free education The greater frequency of broken homes unemployment, and negative family atmosphere, as well as the high rate of pupil turnover (Conant, 1961, Sexton, 1959) are also not conducive to academic achievement.

Negro pupils are undoubtedly handicapped in academic attainment by a lower average level of intellectual functioning than is characteristic of comparable white pupils In both Northern and Southern areas, particularly the latter, Negro pupils have significantly lower IQ s (Carson and Rabin, 1960, Dreger and Miller, 1960, Osborne, 1960) and are retarded in arith metic reading language usage, and ability to handle abstract concepts (Bullock, 1950, Osborne, 1960) The extreme intellectual impoverishment of the Negro home *over and above* its lower social class status reflects the poor standard of English spoken in the home and the general lack of books, magazines, and stimulating conversation

## *Educational and Vocational Aspirations*

All of the factors inhibiting the development of achievement motiva tion and its supportive personality traits in lower class children are intensi fied in the segregated Negro child His over all prospects for vertical social mobility, although more restricted, are not completely hopeless But the stigma of his caste membership is inescapable and insurmountable It is inherent in his skin color, permanently ingrained in his body image, and enforced by the extra legal power of a society whose moral, legal, and re ligious codes formally proclaim his equality

B C Rosen compared the educational and vocational aspirations of Negro boys (age 8 14) and their mothers to those of white Protestant Americans, French Canadians, American Jews, Greek Americans, and Italian Americans The mean vocational aspiration score of his Negro group was significantly lower than the mean scores of all other groups except the French Canadian Rosen concluded that although Negroes have been

> exposed to the liberal economic ethic longer than most of the other groups their culture, it seems is least likely to accent achievement values The Negro s history as a slave and depressed farm worker and the sharp discrepancy between his experience and the American Creed would appear to work against the achieve ment values of the dominant white group Typically the Negro life situation does not encourage the belief that one can manipulate his environment or the convic tion that one can improve his condition very much by planning and hard work (Rosen 1959 p 55)
>
> Negroes who might be expected to share the prevalent American emphasis upon education face the painfully apparent fact that positions open to educated Negroes are scarce This fact means that most Negroes in all likelihood do not con sider high educational aspirations realistic, and the heavy drop-out in high school suggests that the curtailment of educational aspirations begins very early (Rosen 1959 p 58)

Ethnicity was found to be more highly related to vocational aspirations than was social class, sizeable ethnic and racial differences prevailed even when the influence of social class was controlled These results are consistent with the finding that white students tend to prefer very interesting jobs, whereas Negro students are more concerned with job security (Singer and Stefflre, 1956)

### *Sex Differences*

Girls in the segregated Negro community show much greater superiority over boys in academic, personal, and social adjustment than is found in the culture generally (Deutsch and others, 1956) They not only outperform boys academically by a greater margin, but also do so in all subjects rather than only in language skills (Deutsch, and others, 1956) They have higher achievement needs (Gaier and Wambath 1960, Grossack, 1957), have a greater span of attention are more popular with classmates, show more mature and realistic aspirations assume more responsible roles, and feel less depressed in comparing themselves with other children (Deutsch, and others, 1956) Substantially more Negro girls than Negro boys complete every level of education in the United States (Smuts 1957)

Adequate reasons for these differences are not difficult to find Negro children in this subculture live in a matriarchal family atmosphere where girls are openly preferred by mothers and grandmothers, and where the male sex role is generally deprecated The father frequently deserts the family and in any case, tends to be an unreliable source of economic and emotional security (Dai, 1949, Deutsch and others, 1956) Hence, the mother, assisted perhaps by her mother or by a daughter, shoulders most of the burdens and responsibilities of child rearing and is the only dependable adult with whom the child can identify In this environment male chauvinism can obtain little foothold The preferential treatment accorded girls is even extended to opportunities for acquiring ultimate primary status If the family pins all of its hopes on and makes desperate sacrifices for one child, it will often be a daughter in preference to a son Over and above his handicaps at home, the Negro boy also faces more obstacles in the wider culture in realizing his vocational ambitions, whatever they are, than the Negro girl in fulfilling her adult role expectations of housewife, mother, nurse, teacher or clerical worker (Deutsch, and others, 1956)

### *Implications for Education*

Before Negroes can assume their rightful place in a desegregated American culture important changes in the ego structure of Negro children must first take place They must shed feelings of inferiority and self derogation, acquire feelings of self confidence and racial pride, develop realistic aspirations for occupations requiring greater education and training, and develop the personality traits necessary for implementing these aspirations Such changes in ego-structure can be accomplished in two different but complementary ways. First, all manifestations of the Negro's inferior and segregated caste status must be swept away—in education, housing, employment, religion, travel, and exercise of civil rights. This in itself will enhance the Negro's self esteem and open new opportunities for self fulfillment. Second, through various measures instituted in the family, school, and community, character structure, levels of aspiration, and actual standards of achievement can be altered in ways that will further enhance his self-esteem and make it possible for him to take advantage of new opportunities.

DESEGREGATION. Desegregation, of course, is no panacea for the Negro child's personality difficulties. In the first place, it tends to create new problems of adjustment, particularly when it follows in the wake of serious community conflict. Second, it cannot quickly overcome various long standing handicaps which Negro children bring with them to school "such as their cultural impoverishment, their helplessness or apathy toward learning, and their distrust of the majority group and their middle class teachers", nor can it compensate for "oversized classes, inappropriate curriculums, inadequate counseling services, or poorly trained or demoralized teachers" (V. W. Bernard, 1958, p. 158). Yet it is an important and indispensable first step in the reconstitution of Negro personality, since the school is the most strategically placed social institution for effecting rapid change both in ego structure and in social status. A desegregated school offers the Negro child his first taste of social equality and his first experience of first class citizenship. He can enjoy the stimulating effects of competition with white children and can use them as realistic yardsticks in measuring his own worth and chances for academic and vocational success. Under these circumstances, educational achievement no longer seems so pointless, and aspirations for higher occupational status in the wider culture acquire more substance.

It is also reasonable to anticipate that white children will be prejudiced and continue to discriminate against their Negro classmates long after desegregation accords them equal legal status in the educational system. Attitudes toward Negroes in the South, for example, are remarkably stable, even in periods of rapid social change involving desegregation (Young, Benson, and Holtzman, 1960), and are not highly correlated with anti Semitic or other ethnocentric trends (Geenberg, Chase, and Cannon, 1957, Kelly, Ferson, and Holtzman, 1958, Prothro, 1952). Prejudice against Negroes is deeply rooted in the American culture (Raab and Lipset, 1959) and is continually reinforced both by the socio economic gain and by the vicarious ego enhancement it brings to those who manifest it (V. W. Bernard, 1958, O. M. Herr, 1959, Rosen, 1959). It is hardly surprising, therefore, that racial prejudice is most pronounced in lower social class groups (Westie, 1952), and that these groups constitute the hard core of resistance to desegregation (Killian and Haer, 1958, Tumin, 1958). Increased physical contact between white and Negro children does little to reduce prejudice (Neprash 1958 Webster 1961) but more intimate personal interaction under favorable circumstances significantly reduces social distance between the two groups (Kelly Ferson and Holtzman 1958 Mann 1959 Yarrow Campbell and Yarrow 1958)

COMMUNITY ACTION The support of parents and of the Negro community at large must be enlisted if we hope to make permanent progress in the education of Negro children This is the case because the character of the ghetto community largely determines what goes on in the slum school It is therefore wholly unrealistic to contemplate significant change in the school achievement of Negro children without involving the Negro family and community (Conant 1961)

> Whatever can be done to strengthen family life and to give the fathers a more important role in it will make a significant contribution to the development of Negro potential (Smuts 1957 p 462)

Working with mothers and getting them to adopt a more positive attitude toward school is an important first step in improving the educational achievement of urban Negro children (Conant 1961) Typically only 10 percent of Negro parents are high school graduates and only 33 percent complete elementary school (Conant 1961) Thus enrollment of parents in adult education programs would significantly raise the cultural level of the Negro home and stimulate an interest in newspapers magazines and possibly even books One of the troubles is that when the children leave the school they never see anyone read anything—not even newspapers (Conant 1961 p 25) The Higher Horizons project in New York City is a good example of a recent attempt to discover academically talented children in slum areas and encourage them to aspire to college education This program embodies cultural enrichment improved counseling and instruction and the sympathetic involvement of parents

COUNSELING Because of current grave inadequacies in the structure of the lower-class urban Negro family the school must be prepared to compensate at least in part for the deficiencies of the home that is to act so to speak for the parents Teachers in predominantly Negro schools actually perform much of this role at the present time In the lower grades as a matter of fact they are quite successful as mother surrogates. As Negro children approach adolescence however peer-group loyalties become ascendent over the affiliative drive for school achievement inspired by the substitute mother role of Negro teachers and schoolwork progressively deteriorates (Conant 1961)

It is apparent therefore that trained counselors must assume the role of parent substitute during preadolescence and adolescence They are needed to offer appropriate educational and vocational guidance, to encourage worthwhile and realistic aspirations, and to stimulate the development of mature personality traits. In view of the serious unemployment situation among Negro youth, they should also assist in job placement and in cushioning the transition between school and work. This will naturally require much expansion of existing guidance services in the school.

Research has shown that Negro children's distrust of white counselors and authority figures in general makes it extremely difficult for a white counselor to develop an interpersonal relationship with a Negro student such that the latter can gain appropriate insight into his problems. How can the counselor ever hope to view the personal or social worlds as his client does—as he must necessarily do if he wishes to be effective in the counseling situation—if a white person can only imagine but never really know how a Negro actually thinks and feels or how he perceives most personal and social problems? "The cultural lenses which are formulated from unique milieus are not as freely transferable as it is assumed, or as we are led to believe" (W. B. Phillips, 1959, p. 188).

## Motivating the Culturally Deprived Pupil

We have already considered the cognitive characteristics of culturally deprived pupils as well as various instructional measures that can be taken to prevent and ameliorate their educational retardation. In the present context, it is important to realize both that *not all* lower-class children are culturally deprived and that cultural deprivation is not restricted to urban slum environments. Lower class status is a necessary but not a sufficient condition of cultural deprivation. In addition, a culturally deprived home is characterized by extreme intellectual impoverishment, and by what O. Lewis (1961) calls the "culture of poverty." This implies more than economic impoverishment. It also includes attitudes of helplessness, dependency, and marginality, a highly depressed level of aspiration, and a feeling of alienation from the culture at large. Much lower-class Negro culture in the United States, especially that which has been untouched by the civil rights movement, is representative of the culture of poverty. Other examples are found among migrant workers, families for whom relief is an established way of life, and families living in chronically depressed and relatively isolated rural areas.

It only remains in this section to examine some motivational considerations that apply to culturally deprived pupils. The problem of reversibility is particularly salient here, inasmuch as the environment of cultural deprivation typically stunts not only intellectual development but also the development of appropriate motivations for academic achievement.

## *Intrinsic Motivation*

The development of cognitive drive, or of intrinsic motivation for learning (for the acquisition of knowledge as an end in itself or for its own sake), is the most promising motivational strategy which can be adopted in relation to the culturally deprived child. It is true, of course, in view of the anti-intellectualism and pragmatic attitude toward education that is characteristic of lower-class ideology, that a superficially better case can be made for the alternative strategy of appealing to the job-acquisition, retention, and advancement incentives that now apply so saliently to continuing education because of the rapid rate of technological change. Actually, however, intrinsic motivation for learning is more potent, relevant, durable, and easier to arouse than its extrinsic counterpart.

Meaningful school learning, in contrast to most rote kinds of laboratory learning, requires relatively little effort or extrinsic incentive and, when successful, furnishes its own reward. In most instances of school learning, cognitive drive is also the only immediately *relevant* motivation, since the greater part of school learning cannot be rationalized as necessary for meeting the demands of daily living. Furthermore, it does not lose its relevancy or potency in later adult life when utilitarian and career advancement considerations are no longer applicable. Lastly, as we know from the high dropout rate among culturally deprived high school youth, appeals to extrinsic motivation are frequently not very effective because of the prevailing social-class ideology. Among other reasons, this ideology reflects a limited time perspective focused primarily on the present, a character structure that is oriented toward immediate rather than delayed gratification of needs, the lack of personality traits necessary to implement high academic and vocational aspirations due to the absence of necessary family, peer group, and community pressures and expectations, and the seeming unreality and impossibility of attaining the rewards of prolonged striving and self-denial in view of current living conditions and family circumstances, previous lack of school success, and the discriminatory attitudes of middle-class society.

*It must be conceded at the outset that* culturally deprived children typically manifest little intrinsic motivation to learn. They come from family and cultural environments in which the veneration of learning for its own sake is not a conspicuous value, and in which there is little or no tradition of scholarship. Moreover, they have *not* been notably successful in their previous learning efforts in school. Nevertheless, we need not necessarily despair of motivating them to learn for intrinsic reasons. Psychologists have been emphasizing the motivation-learning and the interest-activity sequences of cause and effect for so long that they tend to overlook their reciprocal aspects. Since motivation is not an indispensable condition for short-term and limited quantity learning, it is not necessary to postpone learning activities until pupils develop appropriate interests and motivations Often, as pointed out above, the best way of motivating an unmotivated pupil is temporarily to by pass the problem of motivation and to focus on the cognitive aspects of teaching Much to his surprise and to his teacher s, he will learn despite his lack of motivation, and from the satisfaction of learning and thus satisfying latent cognitive drive, he will characteristically develop the motiva tion to learn more on the same basis

Paradoxically, therefore, we may discover that the most effective method of developing intrinsic motivation to learn in a culturally deprived pupil is to concentrate to teaching him as effectively as possible in the absence of motivation, and to rely on the cognitive motivation that is developed retro actively from successful educational achievement This is particularly true when a teacher is able to generate contagious excitement and enthusiasm about the subject he teaches, and when he is the kind of person with whom culturally deprived children can identify Masculinizing the school and dramatizing the lives and exploits of cultural, intellectual, and scientific heroes can also enhance the process of identification At the same time, of course, we can attempt to combat the anti intellectualism and lack of cul tural tradition in the home through programs of adult education and cultural enrichment

### *Extrinsic Motivation*

As previously indicated the current situation with respect to developing adequate motivations for higher academic and vocational achievement among culturally deprived children is not very encouraging But just as in the case of cognitive drive, much extrinsic motivation for academic success can be generated retroactively from the ego enhancing experience of current success in school work Intensive counseling can also compensate greatly for the absence of the appropriate home, community, and peer group support and expectations necessary for the development and implementation of long term vocational ambitions By identifying with a mature, stable striving, and successful male adult figure culturally deprived boys can be encouraged to internalize long term and realistic aspirations, as well as to develop the mature personality traits necessary for their implementation Hence, as a result of achieving current ego enhancement in the school setting obtaining positive encouragement and practical guidance in the counseling relation ship and experiencing less rejection and discrimination at the hands of school personnel, higher vocational aspirations appear to be more real istically within their grasp Further encouragement to strive for more am bitious academic and vocational goals can be provided by making available abundant scholarship aid to universities community colleges, and technical institutes, by acquainting culturally deprived youth with examples of successful professional persons originating from their own racial, ethnic, and social class backgrounds, and by involving parents sympathetically in the newly fostered ambitions of their children The success of the Higher Horizons Project in New York City indicates that an energetic program organized along these lines can do much to reverse the negative effects of cultural deprivation on the development of extrinsic motivations for academic and vocational achievement

With regard to aversive motivation, it can be argued, of course, that a long history of school failure has a demonstrably negative effect on the academic motivation and achievement of culturally deprived pupils, alienates them from school and school work, and increases their desire to drop out as early as possible It is self-evident, however, that failure and fear of failure cannot motivate academic striving when pupils have never experienced any success in school have given up hope of succeeding, have disinvolved themselves from the school situation, and have internalized no aspirations for academic success But the remedy does not lie in removing the threat of failure from the category of respectable motivations Nor does it lie in the self defeating practice of social promotion which fools nobody, least of all the child who is ostensibly rewarded for failing to learn To be sure, his ultimate academic achievement might be slightly higher if he moves ahead to the next grade instead of repeating the same one, and he may be better adjusted socially by not being socially stigmatized as an oversized dullard by his younger classmates Nevertheless he is still acutely aware of his actual failure in school acquires unrealistic perceptions about the competence reward relationship in the real world, and enters high school as a rebellious semi literate The more constructive remedy is to change the preschool, classroom family, and social environment of the culturally deprived child, as well as his personality structure, so that academic success not only becomes a realistic possibility for him but also becomes internalizable as a realistic aspiration When this happens, he too will be positively motivated, as other pupils are, by desire for knowledge as an end in itself, by ego-enhancing rewards, and by aversive motivations as well

## Chapter 13

# TEACHER CHARACTERISTICS

It seems self evident that the teacher should constitute an important variable in the learning process From a cognitive standpoint it should certainly make a difference, in the first place, how comprehensive and cogent his grasp of his subject matter field is Second, quite independently of his degree of adequacy in this regard, he may be more or less able to present and organize subject matter clearly, to explain ideas lucidly and incisively, and to manipulate effectively the important variables affecting learning Third, in communicating with his pupils, he may be more or less capable of translating his knowledge in a form appropriate for their degree of cognitive maturity and subject matter sophistication Certain key aspects of the teacher's personality would also seem, on a logical basis, to have an important bearing on learning outcomes in his classroom Theoretical considerations suggest that chief among these would be his degree of commitment to or ego involvement in the intellectual development of his pupils and his ability to generate intellectual excitement and intrinsic motivation for learning Apart from these crucial cognitive and personality attributes that impinge directly on the learning process, a broad range of personal characteristics should be reasonably compatible with effectiveness in teaching

Actually, very little is known about which characteristics of teachers make for success in the teaching learning process In part, this situation is a reflection of the difficulty of measuring the aforementioned teacher attributes that seem self-evidently related to pedagogic competence, and of the consequent lack of research evidence on these significant variables In part, also, it is a reflection of the undue emphasis that has been placed over the past three decades on those personality characteristics that were thought to affect the mental health and personality development of children In addition, much of the existing research evidence in this area tends to be ambiguous equivocal, and uninterpretable because of the absence of a satisfactory criterion against which to measure teacher effectiveness Ratings of teacher performance are notoriously unreliable, superficial, subjectivistic, and capricious, and the achievement test scores of pupils, as we shall see later, are limited in depth scope, and validity

But even though teacher training institutions tend to overemphasize the importance of these personality factors, there is some evidence that pupils are primarily concerned with their teachers pedagogic competence or ability to teach, and not with their role as kindly, sympathetic, and cheerful adults (P H Taylor, 1962) Despite the recent trend in such fields as government and business administration to place ability in getting along with people ahead of professional competence, it is obviously a cause for some concern when professional personnel in any field of endeavor are judged mainly on the basis of purely personal qualities Clearly, since teachers deal with impressionable children and affect their personality development they should not have unstable or destructive personalities Nevertheless, the principal criterion in selecting and evaluating teachers should not be the extent to which their personality characteristics conform to some theoretical ideal promoting mental health or personality development, but rather their ability to stimulate and competently direct pupil learning activity

In this chapter it will also be convenient to consider the role and impact of *different styles of teaching on learning* as well as *the problem of* classroom discipline

## The Roles of Teachers

One approach to evaluating teachers characteristics in terms of their relevance for teaching effectiveness is to consider both the different roles that teachers play in our culture as well as the relative importance of these various roles. In recent times, the scope of the teacher's role has been vastly expanded beyond its original instructional core to include such functions as parent surrogate, friend and confidante, counsellor, adviser, representative of the adult culture, transmitter of approved cultural values, and facilitator of personality development, but without in any sense disparaging the reality or significance of these other subsidiary roles, it is nevertheless undeniable that the teacher s most important and distinctive role in the modern classroom is still that of director of *learning activities*[1] Unfortunately, however,

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[1] In directing pupil learning activities, the teacher's chief function no longer is, or should be the giving of information As emphasized above this latter function can be performed *more* efficiently by appropriately programmed instruction materials.

as viewed in retrospect by students, teachers are apparently not impressively effective in any of their roles One sample of college students, for example, reported that only 8 5 percent of their teachers had an important influence on their intellectual or personal development, no appreciable influence in this regard was attributed to over three quarters of the teachers in question (Allport, 1964)

One interesting study of adolescent pupils' perceptions of teachers indicates that teachers are seen as playing three major kinds of roles—as friends, opponents and manipulators of status in learning situations (R Cunningham, 1951) As friends, they are "older and wiser" persons, helpful counsellors, heroes, givers of security, confidantes, and occasionally "pals" As opponents they are cast as 'kill joys" who arbitrarily interfere with legitimate pleasures, as 'enemies to be fought and 'outwitted," and as demons of power to be feared, respected, and placated Much of this latter role obviously represents a displacement of hostile feelings from original parent targets Teachers also share much of the brunt of adolescents general anti adult orientation In the learning aspects of the school situation they are perceived as 'efficient organizers in the direction of work projects, as necessary evils' in the acquisition of knowledge, as 'stepping stones to future status rewards, as dispensers of approval and disapproval, and as moral arbiters who can absolve from guilt as well as point the accusing finger

## Cognitive Abilities

At first glance it might seem that the intelligence of teachers should be highly related to success in teaching Nevertheless teacher effectiveness, as measured by pupil gains in achievement and by principals' and supervisors ratings, is only negligibly related to teachers' intelligence (Barr, and others, 1958, Morsh and Wilder, 1954) In all probability, therefore, intelligence operates as a limiting factor in its influence on teaching success A certain minimal level of intelligence is obviously necessary for teaching effectively But beyond this critical point, the intelligence of teachers may not be significantly related to learning outcomes in pupils, other more important cognitive and personality factors account for most of the difference in effectiveness between successful and unsuccessful teachers

It is self-evident that a teacher cannot furnish adequate feedback to students or clarify ambiguities and misconceptions unless he has a meaningful and adequately organized grasp of the subject he teaches Yet there are no really adequate measures of the teacher's actual grasp of his subject matter field in terms of such crucial dimensions as comprehensiveness, cogency, stability, lucidity and precision of concepts, integration of relationships between component aspect of the field, awareness of significant theoretical issues and underlying philosophical assumptions, appreciation of methodological and epistemological problems and so forth Hence although such factors presumably influence many significant aspects of the pupil s mastery of subject matter and affect his general level of interest in and intellectual excitement about a given discipline we know little that is definite about these important relationships Obviously of course the same difficulties that stand in the way of measuring these significant cognitive variables in teachers create obstacles in measuring corresponding learning outcomes in pupils Actual investigation along these lines has therefore been restricted to the study of relationships between relatively formal and superficial aspects of teachers and pupils mastery of subject matter

In general degree and quality of teachers academic preparation as indicated by grade point average amount of work taken in the major field and achievement test scores bears only a low positive relationship to pupil learning outcomes and supervisors ratings of success in teaching (Barr and others 1958) On theoretical grounds however it seems somewhat unlikely that these aspects of academic preparation are not more highly related to success in teaching than they appear to be The empirically demonstrated low relationship may conceivably reflect in part the superficiality and low intrinsic validity of both the pupil and teacher measures of subject matter mastery It is also possible of course that academic preparation like intelligence may influence teaching effectiveness only when it is below a certain critical level

Since as one might reasonably anticipate the provision of effective feedback depends on clarity and fluency of teacher expression the learning of facts by pupils is significantly related to clarity and expressiveness in the teacher (Solomon Rosenberg and Bezdek 1964) Consistent with this finding is the fact that ideational fluency correlates significantly with ratings of teaching effectiveness (Knoell 1953)

It stands to reason that teachers who display skill imagination and sensitivity in organizing learning activities and in manipulating learning variables should promote superior learning outcomes in pupils This ability after all is a central feature of the teaching process and hence should be a key index of professional competence in teaching Yet, except for a reported positive relationship between orderliness in teachers and reading achievement in pupils (Spaulding 1963) the research evidence is at best sparse and tangential Pupils within a given classroom who judge the teacher as orderly and systematic in his classroom management and arrangement of learning activities report greater accomplishment of work than those of their classmates who make less favorable judgments of the teacher in this regard (Cogan 1958) their classroom behavior is also more productive at the elementary school level (Ryans 1961) Teachers rated as superior by their principals tend to be characterized more than are teachers rated as inferior by a pattern of orderly systematic, responsible and business-like behavior in their classroom procedures (Ryans, 1960) Finally, teachers who are adept at diagnosing learning difficulties and at appreciating the relevance of particular instructional materials for the acquisition of particular learnings are more successful than less adept teachers in terms of pupil achievement (Fattu, 1963)

Unfortunately, no evidence is currently available about the relationship between the teacher's effectiveness and his ability to adapt the communication of ideas to the pupil's level of intellectual maturity and subject matter sophistication Particularly at the elementary school and less advanced levels of instruction, this ability should be significantly related to the acquisition of clear, stable, and unambiguous meanings

## Personality Characteristics

A tremendous literature has accumulated over the past half century on the personality characteristics of teachers Very little of it, however, is illuminating insofar as it indicates the kinds of traits that are associated with success in teaching For the most part, the personality of teachers has been studied either as an end in itself or in relation to those aspects that influence personality development and mental hygiene in the classroom—not in relation to factors that affect learning outcomes or other criteria of teacher effectiveness This has been the case despite the fact that many aspects of a teacher's personality may obviously influence pupils' affective response to him without necessarily influencing the effectiveness of his teaching

It is incontrovertible that pupils respond affectively to the personality characteristics of a teacher, and that this affective response influences their judgments of his instructional effectiveness (F W Hart, 1934) They not only admire teaching skill, clarity, task orientation, and good classroom control, but are also highly appreciative of fairness, impartiality, patience, cheerfulness, and sympathetic understanding In addition they approve of teachers who are interested in pupils and who are helpful, kindly, and considerate of their feelings (F W Hart, 1934, Leeds, 1954) On the other side of the coin, they dislike reluctance to bestow praise, favoritism, punitiveness, irritability, fussiness, garrulousness, bossiness, and brittleness of temper Thus, from the standpoint of simple congeniality, it can certainly do no harm and may do some good if a teacher possesses those characteristics that make him well liked by his pupils Nevertheless, from the standpoint of his principal role in our culture, it is self evidently more important that a teacher be instructionally effective rather than that he be liked or popular

In general, teachers personality characteristics have *not* been highly correlated with effectiveness in teaching The two principal exceptions to this generalization are warmth and understanding, on the one hand, and a tendency to be stimulating and imaginative, on the other Thus, since a wide variety of personality traits appears to be consistent both with instructional effectiveness and with normal personality development and mental hygiene in the classroom, a teacher should not try to remake his personality to conform to the theoretically ideal cluster of characteristics in these respects—even if it were possible to do so The more realistic and defensible course of action for him is to make the most effective use of those personality assets that he enjoys

Teachers who are warm and understanding tend to gratify the affiliative drive of pupils This is particularly important for the many elementary school pupils who seek in teachers a parent surrogate and a source of acceptance and approval indicative of derived status It becomes less important in secondary school and university when affiliative drive constitutes a less salient motivation for learning than the growing need for ego-enhancement and earned status The warm teacher can be identified with easily by pupils He provides emotional support, is sympathetically disposed toward pupils, and accepts them as persons Characteristically he distributes much praise and encouragement and tends to interpret pupil behavior as charitably as possible He is relatively unauthoritarian and is sensitive to pupils' feelings and affective responses For all of these reasons he tends to score high on the Minnesota Teacher Attitude Inventory which is keyed in this direction, and to promote more wholesome self concepts in elementary school pupils (Spaulding, 1963) Warm teachers tend to be rated more favorably by principals, supervisors pupils and other observers (Cook, Leeds, and Callis, 1951, McGee, 1955, Ryans 1960, Solomon, Rosenberg, and Bezdek, 1964)

At all grade levels, including the elementary school, teacher warmth is less important for pupils whose motivational orientation to learning is largely cognitive or ego-enhancing rather than affiliative For such pupils, liking of a teacher is *not* related to the latter s degree of warmth or to his score on the Minnesota Teacher Attitude Inventory (Della Piana and Gage, 1955) In sharp contrast, pupils who *are* highly concerned with their interpersonal relationship to and feelings for a teacher tend to like teachers who are characterized by warmth (who make high scores on the Minnesota Teacher Attitude Inventory), and to dislike teachers who are not.

As a result of identifying with a warm teacher, a pupil is obviously more disposed to assimilate his values Theoretically, also, he should be more highly motivated to learn and thus to attain a higher level of academic achievement. But the evidence tends to be equivocal on this point (Flanders, 1960, Medley and Mitzel, 1959) In any case, however, teacher warmth is significantly related to the amount of work performed by pupils (Cogan, 1958), to pupils' interest in science in general science classes (H B Reed, 1961), and to the 'productiveness' of pupil behavior in the elementary school (Ryans 1961) P S Sears (1963) has presented some evidence which suggests that pupil achievement is more creative when teachers are warm and encouraging

Ability to generate intellectual excitement and intrinsic motivation for learning is another personality characteristic of teachers that appears to have significant implications for their instructional effectiveness Teachers who are lively, stimulating imaginative, and enthusiastic about their subject are judged as more successful by principals and other experienced observers (Ryans, 1960) Under this kind of stimulation, pupil behavior is also more productive, both in the primary and secondary school (Ryans, 1961), and greater gains in pupil comprehension are made (Solomon, Rosenberg and Bezdek, 1964)

Perhaps the most important personality characteristic of teachers in fluencing their effectiveness is the extent of their personal commitment to the intellectual development of pupils There is general agreement that this is a central *component of a teacher s professional motivation* It determines in large measure whether he will expend the necessary effort to teach for real gains in the intellectual growth of pupils or will merely go through the formal motions of teaching Unfortunately, however, since it is a very elusive factor insofar as reliable and valid measurement is concerned, we have no objective evidence regarding its relationship to success in teaching

## Teaching Style

Much has been written and much pseudo-controversy has arisen about matters of teaching style" This confusing debate, largely plagued by am biguity in the meaning of terms, by the emotional use of slogans, and by the absence of definitive evidence, is completely unresolved and promises to yield few clear implications for teaching practice Perhaps the most de fensible conclusion that can be drawn at this point is that variability in teaching style is both inevitable and desirable Styles of teaching vary, in the first place, because teachers' personalities vary What works well for one teacher may be completely ineffective for another A teacher should there fore adapt his instructional style to strengths and weaknesses in his back ground, personality, and preparation This does not mean, of course, that all techniques of teaching are equally effective or that pedagogic technique is not teachable It cannot be assumed, to begin with, that a given teacher necessarily chooses the style that is most appropriate for him, and beyond the assistance that can be given in making this choice, most prospective *teachers can be helped to use their styles more effectively, that is, can be* provided with certain relevant techniques or shown how to use them to greater advantage

It is also desirable for teaching styles to vary because of variability in pupil needs and characteristics One important pupil characteristic previously stressed in this regard is the difference in learning styles between satellizers and nonsatellizers Other important characteristics are intelligence, anxiety level, interest in subject matter, the prevailing degree of authoritarianism in the adult child relationship that is typical of a given social class background, and the student's degree of independence and security (Wispé, 1951) Lastly, appropriate teaching style is always relative to the particular educational objective that is being striven for at a given moment, that is, the efficient transmission of established knowledge, the generation or modification of attitudes, the improvement of problem solving abilities, or the exploration and refinement of alternative viewpoints in controversial areas of knowledge

### *Lecture versus Discussion*

Most of the discussion about teaching style has centered around the lecture versus discussion issue Most of the studies concerned with this problem report little difference between the two methods in terms of student mastery of subject matter (G G Stern, 1963, Wallen and Travers, 1963), where differences do appear they are usually in favor of the lecture method Although there is surprisingly little direct evidence that the lecture method facilitates problem solving and the application of knowledge, B S Bloom (1953) reported that this method stimulates more relevant student thinking Even when great reliance is placed on lecturing, it is evident that some discussion is necessary if students are to receive adequate feedback and if the teacher is to ascertain whether his listeners are following him

The choice between lecture and discussion methods depends both on the personality of the teacher and on whether the topic in question is more or less factual or controversial Some teachers are more capable than textbook writers of interpreting, integrating, and drawing together scattered materials from diverse sources and of presenting alternative viewpoints in a highly organized and incisive fashion, but are relatively incapable of and feel very uncomfortable about directing discussion Others are masterful in guiding discussion along fruitful lines or in using a Socratic type of questioning The unique advantages of discussion, particularly in controversial and poorly established areas of knowledge have been described in another context. It cannot be too strongly emphasized, however, that discussion techniques cannot be expected to enhance learning outcomes in a given area unless students possess the necessary background information prerequisite for intelligent and informed discussion When this prerequisite condition is lacking, discussion understandably amounts to little more than the sharing of ignorance, prejudice, platitudes, preconceptions, and vague generalities

### *Group-Centered versus Teacher Oriented Approaches*

Group-centered as opposed to teacher oriented, teaching styles place greater emphasis on student activity, on pupil participation, initiative, and responsibility in setting course objectives, in determining course content, and in evaluating learning outcomes, and on the teacher s role as a non directive group leader These styles of teaching apparently do not differ significantly from teacher-directed approaches with respect to student achieve ment or liking for subject matter (R C Anderson, 1959, Spaulding, 1963, G G Stern, 1963), but are superior with respect to such outcomes as in creased group cohesion (Benne and Levit, 1953, Lippitt, 1940, Tizard, 1953), less dependence on the teacher (Asch, 1951, Lippitt, 1940), and improvement in group and adjustment skills (Asch, 1951, Lippitt, 1940) Democratic teach ing however, does not increase creativity or improve pupils self concepts (Spaulding, 1963)

In a group-centered program care must be taken neither to confound democratic discipline with a laissez faire approach nor to abdicate the school s *primary responsibility for organizing the curriculum Students* should not be given a great deal of responsibility for structuring courses or for evaluating learning outcomes unless their background in the field is adequate and unless they have prior experience in independent study and group-centered techniques On the whole, students who prefer non directive approaches tend to be more secure and independent (Patton, 1955, Wispe, 1951), to be more flexible, to have more self insight, and to be better able to cope with ambiguity (McKeachie, 1962) It is also unwise for teachers to adopt a nondirective teaching style either when they feel temperamentally uncomfortable with it or when pupils are generally insecure, compulsive, or of lower class origin

## School Discipline

Since a certain minimal level of order and decorum is necessary for effi cient school learning discipline is a real and prevalent problem in the class room It is a serious concern of most teachers and especially of those who are beginning their teaching careers (Eaton, Weathers and Phillips, 1957, Ladd 1958), *it is not just a problem of the ineffective or maladjusted teacher* Viewed in this context of relevance for classroom learning it is evident that discipline should be as impersonal and task-oriented as possible That is objectionable pupil behavior should be proscribed, punished, and prevented primarily because it interferes with classroom learning and not because it is personally distasteful or threatening Personal punitiveness on the part of teachers leads to exaggerated pupil perceptions of the seriousness of mis behavior, less perceived teacher fairness (Kounin, Gump, and Ryan, 1961), more aggressive kinds of misconduct, more conflictful pupil attitudes about misbehavior, and less concern with learning and distinctive school values (Kounin and Gump, 1961)

In contrast to disciplinary practices in other countries, the typical American approach to school discipline is impressively incidental Classroom discipline in the United States does not connote explicit subjection to authority and implicit habits of obedience that are enforced by a heavy handed set of controls and punishments, it does not imply an easily identifiable atmosphere of classroom control which the teacher maintains with much deliberate effort—in much the same sense that he strives to have his pupils understand and assimilate the subject matter he teaches Our teachers, rather, tend to feel that the cause of discipline is adequately served if pupils exercise sufficient self control and observe a minimum set of rules with sufficient decorum to enable classroom work to proceed in an orderly, efficient manner They do not in other words strive deliberately for discipline as an explicit goal in its own right They assume instead that good discipline is *ordinarily* a natural by product of interesting lessons and of a wholesome teacher pupil relationship, that the vast majority of pupils respond positively to fair and kindly treatment and that respect for the teacher is a usual accompaniment of the latter s superior knowledge, experience, and status as a leader, and does not have to be reinforced by such artificial props and status symbols as differences in clothing mode of address, and fear of the strap

### *Science or Opinion*

Discipline today is much less a science than a matter of opinion It not only shifts in response to various social economic and ideological factors, but also manifests all the cyclical properties of fads and fashions Objective scientific evidence about the relative merits of different types of discipline is extremely sparse Indeed it is highly questionable to what extent valid empirical data are obtainable and even relevant in matters of discipline Whether or not particular disciplinary practices are appropriate depends, in the first place, on the particular values, institutions and kinds of personal relationships prevailing in a given culture, and second, any definitive empirical test of appropriateness would have to be conducted over such an extended period of time that its conclusions would tend to be rendered obsolete by intervening changes in significant social conditions For all practical purposes therefore, the choice of disciplinary policy involves taking a rationally defensible and self consistent position based on value preferences, on relevant considerations of child development, and on individual experience and judgment

Because discipline cannot be placed on a largely scientific basis, however, does not mean that one position is as good as another or that no public policy whatsoever is warranted Society is continually obliged to resolve issues of much greater moment with even less objective evidence on which to base a decision Under the circumstances all we can reasonably expect is greater humility and less dogmatism on the part of those engaged in formulating disciplinary policy Thus the most disturbing aspect of the entire problem is not the fact that there is precious little scientific evidence to support the disciplinary doctrines expounded in our colleges of education and educational journals and textbooks, but rather the ubiquitous tendency to represent purely personal opinions and biases as if they were incontrovertibly established findings of scientific research

## *The Definition and Functions of Discipline*

By discipline is meant the imposition of *external* standards and controls on individual conduct Permissiveness, on the other hand refers to the absence of such standards and controls To be permissive is to let alone,' to adopt a laissez faire policy Authoritarianism is an excessive, arbitrary, and autocratic type of control which is diametrically opposite to permissiveness Between the extremes of laissez faire permissiveness and authoritarianism are many varieties and degrees of control One of these, to be described in greater detail below, is democratic discipline When external controls are internalized we can speak of self discipline, it is clear, nonetheless, that the original source of the controls, as well as much of their later reinforcement are extrinsic to the individual

Discipline is a universal cultural phenomenon which generally serves four important functions in the training of the young First, it is necessary for socialization—for learning the standards of conduct that are approved and tolerated in any culture Second, it is necessary for normal personality maturation—for acquiring such adult personality traits as dependability, self reliance, self control, persistence, and ability to tolerate frustration These aspects of maturation do not occur spontaneously, but only in response to sustained social demands and expectations Third, it is necessary for the internalization of moral standards and obligations or, in other words for the development of conscience Standards obviously cannot be internalized unless they also exist in external form, and even after they are effectively internalized universal cultural experience suggests that external sanctions are still required to insure the stability of the social order Lastly discipline is necessary for children s emotional security Without the guidance provided by unambiguous external controls they tend to feel bewildered and apprehensive Too great a burden is placed on their own limited capacity for self control

From the standpoint of school learning as pointed out above discipline is also necessary for the orderly regulation of classroom activities

### *Democratic Discipline*

The proponents of democratic classroom discipline believe in imposing the minimal degree of external control necessary for socialization personality maturation conscience development classroom learning and the emotional security of the child. Discipline and obedience are regarded only as means to these ends and not as ends in themselves They are not striven for deliberately but are expected to follow naturally in the wake of friendly and realistic teacher pupil relationships Explicit limits are not set routinely or as ways of showing who is boss but only as the need arises—when they are *not* implicitly understood or accepted by pupils

Democratic discipline is as rational nonarbitrary and bilateral as possible It provides explanations permits discussion and invites the participation of children in the setting and enforcement of standards whenever they are qualified to do so Above all it implies respect for the dignity of the individual makes its primary appeal to self-controls and avoids exaggerated emphasis on status differences and barriers between free communication Hence it repudiates harsh abusive and vindictive forms of punishment and the use of sarcasm ridicule and intimidation

The aforementioned attributes of democratic classroom discipline are obviously appropriate in cultures such as ours where social relationships tend to be egalitarian This type of discipline also becomes increasingly more feasible as children become older more responsible more capable of self-control and group control and more capable of understanding and formulating rules of conduct based on concepts of equity and reciprocal obligation But contrary to what the extreme permissivists would have us believe democratic school discipline does not imply freedom from all external constraints standards and direction or freedom from discipline And under no circumstances does it presuppose the eradication of all distinctions between pupil and teacher roles or require that teachers abdicate responsibility for making the final decisions in the classroom

### *Distortions of Democratic Discipline*

Many educational theorists have misinterpreted and distorted the ideal of democratic discipline by equating it with an extreme form of permissiveness These distortions have been dogmatically expressed in various psychologically unsound and unrealistic propositions that are considered sacrosanct in many teachers colleges Fortunately however most classroom teachers have only accepted them for examination purposes—while still in training—and have discarded them in actual practice as thoroughly unworkable

According to one widely held doctrine, only "positive" forms of discipline are constructive and democratic It is asserted that children must be guided only by reward and approval, that disapproval, reproof, and punishment are authoritarian repressive, and reactionary expressions of adult hostility which leave permanent emotional scars on children's personalities What these theorists conveniently choose to ignore, however, is the fact that it is impossible for children to learn what is *not* approved and tolerated, simply by generalizing in reverse from the approval they receive for behavior that *is* acceptable Even adults are manifestly incapable of learning and respecting the limits of acceptable conduct unless the distinction between *what is proscribed and approved is reinforced* by *punishment* as well as by reward Furthermore, there is good reason to believe that acknowledgment of wrong-doing and acceptance of punishment are part and parcel of learning moral accountability and developing a sound conscience Few if any children are quite so fragile that they cannot take deserved reproof and punishment in stride

A second widespread distortion of democratic discipline is reflected in the notion popular among educational theorists that there are no culpably misbehaving children in the classroom, but only culpably aggressive, unsympathetic, and punitive teachers If children misbehave, according to this *point of view, one can implicitly assume that they must have been provoked* beyond endurance by repressive and authoritarian classroom discipline Similarly, if they are disrespectful, then the teacher, by definition, must not have been deserving of respect It is true, of course, that much pupil misconduct *is* instigated by harsh and abusive school discipline, but there are also innumerable reasons for out-of bounds behavior that are completely independent of the teacher's attitudes and disciplinary practices The misbehavior of pupils is also influenced by factors originating in the home, the neighborhood, the peer group, and the mass-media Some children are emotionally disturbed, others are brain-damaged, and still others are aggressive by *temperament, and there are times when even the best behaved children* from the nicest homes develop an irresistible impulse—without any provocation whatsoever—to test the limits of a teacher s forbearance

Both of the aforementioned distortions of classroom democracy are often used to justify the commonly held belief among educational theorists that pupils should not be reproved or punished for disorderly or discourteous conduct One can, for example, observe classrooms where everybody talks at once where pupils turn their backs on the teacher and engage in private conversation while the latter is endeavoring to instruct them, and where pupils verbally abuse teachers for exercising their rightful disciplinary prerogatives Some educators contend that all of this is compatible with wholesome, democratic teacher pupil relationships Other educators deplore this type of pupil behavior but insist, nevertheless, that punishment is un warranted under these circumstances In the first place, they assert, reproof or punishment constitutes a negative and hence axiomatically undesirable approach to classroom management, and, second, the misbehavior would assuredly have never occurred to begin with, if the teacher s attitudes had been less autocratic or antagonistic The arguments of the second group of educators have already been answered, and to the first group it can be said that rudeness and unruliness are not normally desirable classroom behavior in any culture

When such misconduct occurs, pupils have to be unambiguously in formed that it will not be tolerated and that any repetition of the same behavior will be punished This action does not preclude in any way either an earnest attempt to discover why the misbehavior occurred, or suitable preventive measures aimed at correcting the underlying causes But, by the same token the mere fact that a pupil has a valid psychological reason for misbehaving does not mean that he is thereby absolved from moral account ability or rendered no longer subject to punishment

Still another related distortion of democratic discipline is reflected in the proposition that it is repressive and authoritarian to request pupils to apologize for discourteous behavior or offensive language However if we take seriously the idea that the dignity of the human being is important, we must be willing to protect it from affront, and apology is the most civi lized and effective means mankind has yet evolved for accomplishing this goal In a democratic society nobody is that important that he is above apologizing to those persons whom he wrongfully offends Everybody s dig nity is important—the teacher s as well as the pupil s It is no less wrong for a pupil to abuse a teacher than for a teacher to abuse a pupil

If apologies are to have any real significance in moral training, however, it is obvious that, even though they are explicitly requested, they must be made voluntarily and must be reflective of genuine appreciation of wrong doing and of sincere regret and remorse Purely formal and mechanical statements of apology made under coercion are less than worthless Apol ogies are also without real ethical import unless their basis is reciprocal, that is, unless it is fully understood that under comparable circumstances the teacher would be willing to apologize to his pupils

### *What Needs To Be Done*

In seeking to correct these undesirable permissive distortions of class room democracy, it would be foolhardy to return to the equally undesirable opposite extreme of authoritarianism that flourished in this country up to a quarter of a century ago, and still prevails in many Western nations. Democratic school discipline is still an appropriate and realistic goal for American education, hence there is no need to throw away the baby with the bath water. It is only necessary to discard the aforementioned permissivist doctrines masquerading under the banners of democracy and behavioral science, and to restore certain other traditional American values that have been neglected in the enthusiasm of extending democracy to home and school.

More specifically, we first have to clear up the semantic confusion. We should stop equating permissiveness with democratic discipline, and realistic adult control and guidance with authoritarianism. Permissiveness, by definition, is the absence of discipline, democratic or otherwise. We should cease instructing teachers that it is repressive and reactionary to reprove or punish pupils for misconduct, or to request them to apologize for offensive and discourteous behavior.

Second, we should cease misinterpreting what little reputable evidence we have about discipline, and refrain from misrepresenting our personal biases on the subject as the indisputably established findings of scientific research. *The available evidence merely suggests that in our type of cultural setting,* authoritarian discipline has certain undesirable effects—*not* that the consequences of laissez faire permissiveness are desirable. As a matter of fact, research studies show that the effects of extreme permissiveness are just as unwholesome as are those of authoritarianism. In the school situation a laissez faire policy, as pointed out above, leads to confusion, insecurity, and competition for power among pupils. Assertive pupils tend to become aggressive and ruthless, whereas retiring pupils tend to withdraw further from classroom participation. The child who is handled too permissively at home tends to regard himself as a specially privileged person. He fails to learn the normative standards and expectations of society, to set realistic goals for himself, and to make reasonable demands on others. In his dealings with adults and other children he is domineering, aggressive, petulant, and capricious.

Third, we should stop making teachers feel guilty and personally responsible for all instances of misconduct and disrespect in the classroom. We do this whenever we take for granted, without any actual supporting evidence, that these behavior problems would never have arisen in the first place if the teachers involved were truly deserving of respect and had been administering genuinely wholesome and democratic discipline.

Finally, teachers colleges should terminate the prevailing conspiracy of silence they maintain about the existence of disciplinary problems in the public schools. Although discipline is the one aspect of teaching that the beginning teacher is most worried about, he receives little or no practical instruction in handling this problem. Colleges of education, as pointed out above, rationalize their inadequacies in this regard by pretending that disciplinary problems are relatively rare occurrences involving the disturbed child, or more typically the disturbed teacher Due respect for the facts of life, however, suggests that prospective teachers today not only need to be taught more realistic propositions about the nature and purposes of democratic discipline, but also require adequately supervised, down to-earth experience in coping with classroom discipline

# DISCOVERY LEARNING

## Chapter 14

# LEARNING BY DISCOVERY

Learning by discovery has its proper place in the repertoire of accepted *pedagogic techniques available to teachers*. For certain designated purposes and for certain carefully specified learning situations, its rationale is clear and defensible. But learning by discovery also has its own *elaborate mystique*. *Its legitimate uses and advantages have been unwarrantedly* extrapolated to include educational goals, levels of intellectual maturity, levels of subject matter sophistication, and levels of cognitive functioning for which it is ill adapted—and for reasons which derive from sheer dogmatic assertion, from pseudonaturalistic conceptions about the nature and conditions of intellectual development, from outmoded ideas about the relationship between language and thought, from sentimental fantasies about the nature of the child and the aims of education, and from uncritical interpretation of the research evidence. The chief aim of this chapter is to distinguish between the psychological rationale and the psychological mystique of the so-called discovery method of teaching—because there is a pressing need in these troubled times to dispense with sentimental fantasy and euphoric slogans and to get on with the realistic business of education. This means helping schools do well the kinds of jobs that schools can *really* do best, namely, developing more efficient and appropriate ways of selecting, organizing, and presenting significant knowledge to students so that they can learn and retain it meaningfully—both as an end in itself and as a basis for future learning and problem solving.

### Historical Antecedents

Before attempting to set forth the rationale and mystique of the discovery method, it might be helpful briefly to consider the more important of the numerous educational movements and currents of thought from which it has evolved Some of its historical antecedents are relatively recent whereas others have flourished for centuries Unfortunately also not all of these precursory trends are logically compatible with each other

The progressive education movement obviously furnished several major strands in the design of the discovery method One aspect of this movement was a growing dissatisfaction with the empty formalism of much educational content in the latter part of the nineteenth century and the early part of the twentieth century with stultifying drill and catechism like methods of teaching with the curriculum s lack of relatedness to the everyday experience of the child his physical world and social environment and with pupils rote verbalization and memorization of ideas for which they had no adequate referents in experience Overstatement of the realities underlying this dissatisfaction constituted the basis of the later mystique that *all* verbal learning is little more than glib verbalism and parrot like recitation This led in turn to the exaggerated emphasis that progressivists placed on direct immediate and concrete experience as a prerequisite for meaningful understanding on problem solving and inquiry and on incidental learning and learning in natural uncontrived situations From this type of emphasis grew activity programs and project methods and the credo of learning for and by problem solving as the principal objective and method respectively of the educational enterprise Two final by products of this point of view were deification of the act of discovery associated with the inductive and incidental learning methods of teaching and extrapolation to the secondary school and university student of the elementary school child s dependence on recent concrete-empirical props in the comprehension and manipulation of ideas As we shall see later both of these developments became extremely important components of the mystique of learning by discovery

Such modern proponents of the discovery method as G Hendrix acknowledge their historical and ideological kinship to the progressive education movement but are quick to dissociate themselves for some of the basic assumptions made by the inductive and incidental learning approaches to instruction Hendrix (1961 p 296) quite rightly points out that the main fallacy of the inductive approach lies in the teacher s use of the pupil s ability to verbalize a discovery as the criterion by which [she] recognizes that discovery has taken place And in referring to the incidental learning that purportedly occurs in the course of a pupil s involvement in a project or activity program Hendrix (1961 p 293) correctly berates the advocates of this method because all too often they took no responsibility for seeing that instances of the same generalization came along close enough together for the learner to become aware of either concepts or principles

A second aspect of the progressive education movement relevant to the evolution of the discovery method was the child-centered approach to instruction that originated in the educational philosophies of Rousseau and

Froebel The adherents of this approach emphasized the importance of structuring the curriculum in terms of the nature of the child and of his participation in the educative process, that is, in terms of his current interests, his *endogenously derived needs, and his state of intellectual and emotional* readiness According to this point of view, the educational environment facilitates development best by providing a maximally permissive field that does not interfere with the predetermined process of spontaneous maturation The child himself, it is asserted, is in the most strategic position *to know and select those educational ingredients that correspond most* closely to his prevailing developmental needs, and hence are most conducive to his optimal growth Propositions such as these obviously make a fetish of autonomy and self-discovery, and regard as little short of sacrilege any form of guidance or direction in learning, and particularly the communication of insights or generalizations by teachers to pupils Herein lies, in part, the origin of the mystique that expository teaching is inherently authoritarian on developmental grounds, and that self discovered insights are uniquely and transcendentally endowed with meaning and understanding that can be achieved through no other means Hendrix (1961, p 296), for example, castigates didactic exposition of generalizations as "authoritarian" and as only 'satisfying to someone who *is already aware* of the ideas being presented This same mystique also underlies the quite different educational doctrine that it is authoritarian (undemocratic) for a knowledgeable person to communicate his knowledge to other persons lacking his particular background of thought and study, and that the latter individuals can learn more through 'democratic discussion "

These two strands of the progressive education movement—emphasis on the child s *direct experience and spontaneous interests, and insistence on* autonomously achieved insight free of all directive manipulation of the learning environment—set the stage for the subsequent deification of problem solving, laboratory work, and naive emulation of the scientific method Many mathematics and science teachers were rendered self conscious about *systematically presenting and explaining to their* students the basic concepts and principles of their fields, because it was held that this procedure would promote glib verbalism and rote memorization It was felt that if students worked enough problems and were kept busy pouring reagents into a sufficient number of test tubes, they would somehow spontaneously discover in a meaningful way all of the important concepts and generalizations they needed to know in the fields they were studying

Of course, one had to take pains to discourage students from rotely memorizing formulas, and then mechanically substituting for the general terms in these formulas the particular values of specified variables in given problems This would naturally be no less rote than formal didactic exposition Hence, in accordance with the new emphasis on *meaningful* problem solving students ceased memorizing formulas, memorizing instead type problems They learned how to work exemplars of all of the kinds of problems they were responsible for and then rotely memorized both the form of each type and its solution Thus equipped it was comparatively easy to sort the problems with which they were confronted into their respective categories and spontaneously proceed to discover meaningful solutions — provided of course that the teacher played fair and presented recognizable exemplars of the various types [1]

Similarly as the terms laboratory and scientific method became sacrosanct in American high schools and universities students were coerced into mimicking the externally conspicuous but inherently trivial aspects of scientific method They wasted many valuable hours collecting empirical data which at the very worst belabored the obvious and at the very best helped them rediscover principles which could easily be presented verbally in a matter of minutes Actually they learned precious little subject matter and even less scientific method from this procedure The unsophisticated scientific mind is only bewildered by the natural complexities of empirical data and learns much more from schematic models and diagrams Following laboratory manuals in cookbook fashion without adequate knowledge of the relevant methodological and substantive principles involved confers about as much genuine appreciation of scientific method as putting on a white lab coat and doing a TV commercial for a patent remedy

Partly as a result of the superstitious faith of educators in the magical efficacy of problem solving and laboratory methods we have produced in the past four decades millions of high school and college graduates who never had the foggiest notion of the meaning of a variable of a function of an exponent of calculus of molecular structure or of electricity but who have done all of the prescribed laboratory work and have successfully solved an acceptable percentage of the required problems in differential and integral calculus in logarithms in molar and normal solutions and in Ohm s law

One basic lesson that some modern proponents of the discovery method have drawn from this educational disaster is that problem solving in itself does not guarantee meaningful discovery Problem solving can be just as deadening just as formalistic, just as mechanical just as passive and just as rote as the worst form of verbal exposition The types of learning out comes that emerge are largely a function of the structure the organization and the spirit of the problem solving experiences one provides. However an equally important lesson which these same proponents of the discovery method refuse to draw is that because of the educational logistics involved even the best program of problem solving experience is no substitute for a

[1] In some instances, transferability did not even extend to a change in algebraic notation E. L. Thorndike (1922) found that some students who could square $(x + y)$ could not square $(B_1 + B_2)$

minimally necessary amount of appropriate didactic exposition But this minimum will never be made available as long as we adhere to the standard university formula of devoting one hour of exposition to every four hours of laboratory work and paper and pencil problem solving

Historically, the discovery method may also be considered, in part a revolt against the prevailing educational psychology of our time, which is largely an eclectic hodge podge of logically incompatible theoretical propositions superimposed upon a sterile empiricism Perhaps the most significant example of this self defeating eclecticism has been the stubborn attempt made by various psychologists to integrate Thorndikian connectionism and a widely extrapolated neo Behaviorism with the major tenets of progressive education *But the glaring contradictions that resulted from the effort* to reconcile such antithetical sets of principles as the Law of Effect, drive reduction, stimulus response and rote learning theory the transfer of identical elements, and trial and-error learning, on the one hand, and progressivist viewpoints regarding the understanding of ideas, active inquiry, *and autonomous discovery, on the other hand, tended to alienate some of* the more independent minded educational psychologists in the progressive education camp Some defected to psychoanalysis, spawning a weird synthesis of Deweyism and Freudianism, whereas others were attracted by the greater emphasis on cognition and insightful problem solving which characterized *such field theorists* and Gestalt theoreticians as Tolman, Lewin, Kohler, Wertheimer, and Katona Also included among the defectors were many vigorous supporters of the discovery method, who viewed the extrapolation of rote learning theory to verbal classroom learning as sufficient proof of the essentially rote nature of verbal learning, and as ample justification for designing nonverbal discovery techniques of teaching

A final current of educational thought influencing the evolution of the discovery method is the militant sentimentality underlying the currently popular educational objective of making *every* child a critical and creative thinker This objective is, in part, a wish fulfilling extension of our present day *preoccupation with actualizing the creative potentialities of gifted* children But it also harks back to certain conceptions within the mental measurement movement and to the official environmentalistic bias of progressive education

## Psychological and Educational Rationale of the Discovery Method

An all or none position regarding use of the discovery method is warranted by neither logic nor evidence The method itself is very useful for certain pedagogic purposes and in certain educational circumstances The objectionable aspects of the method are certain unwarranted assumptions, overstated claims, inadequately tested propositions, and, above all, some of the reasons advanced for its efficacy

It is evident that the young human being must receive considerable instruction but also that he should be eternally vigilant in making additional observations His life is a complicated blending of instruction and discovery Many facts will be handed to him outright At the same time during every day of his life, he will be engaged almost unknowingly in inductive reasoning the process of bringing together a number of experiences and extracting from them some common factor The issue becomes then not instruction versus discovery since both are essential, but a consideration of the relative importance to be accorded each in the educational process (Stanley 1949 p 457)

What are some of the legitimate claims, the defensible uses, and the palpable advantages of the discovery method? In the early, unsophisticated stages of learning any abstract subject matter, particularly prior to adolescence, the discovery method is extremely helpful It is also indispensable for testing the meaningfulness of knowledge and for teaching scientific method and effective problem solving skills As an adjunctive pedagogic technique it can be very useful for increasing the meaningfulness of material presented primarily by expository methods Finally, various cognitive and motivational factors undoubtedly enhance the learning, retention, and transferability of potentially meaningful ideas learned by discovery

Occasional use of inductive discovery techniques for teaching subject matter content is didactically defensible when pupils are in the *concrete* operational stage of cognitive development It is true of course, that only the availability of some concrete-empirical experience is necessary to generate the semi abstract or intuitive level of meaningfulness characteristic of this stage of cognitive development Hence, either simple verbal exposition, using concrete-empirical props, or a semi autonomous type of discovery, accelerated by the judicious use of prompts and hints is adequate for teaching simple and relatively familiar new ideas But when the learning task is more difficult and unfamiliar, autonomous discovery probably enhances intuitive meaningfulness by intensifying and personalizing both the concreteness of experience and the actual operations of abstracting and generalizing from empirical data *In these circumstances also, the time-cost* disadvantage of discovery learning is relatively less serious, since the time-consuming concrete-empirical aspects of learning must take place anyway, and since a large volume of subject matter cannot be covered in any case during the elementary school period

In lesser degree, this same rationale also applies to adolescents and adults who are relatively unsophisticated in the basic concepts and terminology of a given discipline The older individual, however, has the benefit of greater general cognitive sophistication and linguistic facility, as well as of past successful experience in meaningfully relating abstractions to each other without the aid of concrete empirical props Hence, he will move through the intuitive, subverbal phase of insightful understanding much more rapidly than the comparably unsophisticated child, and, unlike the latter, *will soon dispense with this phase entirely*

The discovery method also has obvious uses in evaluating learning out comes and in teaching problem solving techniques and appreciation of scientific method There is no better way of developing effective skills in hypothesis making and testing, desirable attitudes toward learning and inquiry, toward guessing and hunches, toward the possibility of solving problems on one s own , [and] attitudes about the ultimate orderliness of nature and a conviction that order can be discovered (Bruner, 1960, p 120) As a matter of fact, this is the major rationale for laboratory work In addition, independent problem solving is one of the few feasible ways of testing whether students really comprehend the ideas they are able to verbalize

Finally, in spite of the inconclusive empirical evidence, when all is said and done and one has properly discounted the exaggerated claims made for the unique virtues of learning by discovery, as well as the fanciful reasons offered for these virtues, it still seems plausible to suppose that the greater effort, motivation, excitement, and vividness associated with independent discovery lead to somewhat greater learning and retention One might expect the advantages conferred by discovery techniques to be even greater with respect to transferability, since the experience gained from formulating a generalization from diverse instances obviously facilitates the solution of problems involving this generalization

The crucial points at issue, however, are not whether learning by discovery enhances learning, retention, and transferability, but whether (a) it does so *sufficiently*, for learners who are capable of learning concepts and principles meaningfully *without* it, to warrant the vastly increased ex penditure of time it requires, and (b) in view of this time cost consideration, the discovery method is a feasible technique for transmitting the substantive content of an intellectual or scientific discipline to cognitively mature students who have already mastered its rudiments and basic vocabulary It is largely to an exploration of these issues that the remainder of this chapter is devoted

## Psychological and Educational Limitations of Learning by Discovery

For purposes of analysis, the psychologically and educationally unten able arguments advanced in support of learning by discovery can be con veniently considered under the following twelve headings All real knowl edge is self-discovered Meaning is an exclusive product of creative nonverbal discovery Subverbal awareness is the key to transfer The discovery method is the principal method for transmitting subject matter content Problem solving ability is the primary goal of education Training in the heuristics of discovery is more important than training in subject matter Every child should be a creative and critical thinker Expository teaching is authoritarian Discovery organizes learning effectively for later use Discovery is a unique generator of motivation and self-confidence Discovery is a prime source of intrinsic motivation and Discovery ensures conservation of memory

## *All Real Knowledge Is Self Discovered*

The most general and metaphysical of the twelve propositions is the familiar assertion that to *really* possess knowledge or acquire an idea, the learner must discover it by himself or through his own insight This proposition stems in part from the deification of the act of creative discovery in the problem solving activity program approach to teaching and from John Dewey s extreme preference for problem solving ability rather than ability to acquire knowledge as the proper criterion of intelligence It is also partly derived from the child-centered and client-centered doctrines that the individual himself is best equipped to regulate the process of learning about himself and his universe and therefore that any tampering with this autonomy is by definition detrimental to learning outcomes

More recently a sentimental type of Rousseauean mysticism and primitivism has become fashionable and has been superimposed upon the aforementioned ideological substrate It is best exemplified by J Bruner s statement that

> If man s intellectual excellence is the most his own among his perfections, it is also the case that the most uniquely personal of all that he knows is that which he has discovered himself [Discovery creates] a special and unique relation between the knowledge possessed and the possessor The transition to adulthood involves an introduction to new realms of experience the discovery and exploration of new mysteries, the gaining of new powers This is the heady stuff of education and it is its own reward (Bruner 1961a pp 22, 76)

In accordance with this conception of the true nature of genuine knowledge Bruner formulates the objectives of education as follows

> School should provide not simply a continuity with the broader community or with everyday experience It is the special community where one experiences discovery by the use of intelligence where one leaps into new and unimagined realms of experience experience that is discontinuous with what went before Education must also seek to develop the processes of intelligence so that the individual

is capable of going beyond the cultural ways of his social world able to innovate in however modest a way so that he can create an interior culture of his own For whatever the art the science the literature the history and the geography of a culture each man must be his own artist his own scientist his own historian his own navigator (Bruner 1961b pp 76 59)

It is perfectly true of course that one cannot simply soak up one s culture like a piece of blotting paper and expect it to be meaningful But who advocates doing anything of the kind? The very processes of perception and cognition necessarily require that the cultural stimulus world must first be filtered through each individual s personal sensory apparatus and cogni tive structure before it can have any meaning Meaning can never be any thing more than a *personal* phenomenological product that emerges when potentially meaningful ideas are integrated within an individually unique cognitive structure Invariably therefore the achievement of meaning re quires translation into a personal frame of reference and reconciliation with established concepts and propositions All of this goes on in any program of meaningful *expository teaching and is obviously a far cry from the straw* man picture of passive absorption which Bruner draws to disparage this method and thereby enhance the relative attractiveness of learning by dis covery Most of what anyone *really* knows consists of insights discovered by *others* that have been communicated to him in meaningful fashion

Quite apart from its lack of face validity the proposition that every man must discover for himself every bit of knowledge that he *really* wishes to possess is in essence a repudiation of the very concept of culture For perhaps the most unique attribute of human culture which distinguishes it from every other kind of social organization in the animal kingdom is pre cisely the fact that the accumulated discoveries of millennia can be trans mitted to each succeeding generation in the course of childhood and youth and need not be discovered anew by each generation This miracle of culture is made possible only because it is so much less time consuming to communi cate and explain an idea meaningfully to others than to have them redis cover it by themselves

The infant is born into a logically ordered world abounding in problem solu tions accumulated during the long span of mankind s sojourn on earth and this distilled wisdom called culture constitutes his chief heritage Were it wiped away he would become in all respects a wild animal even less well equipped to cope with nature than are the instinct aided beasts of the jungle An individual is sagacious in direct proportion to the facility with which he can acquire and use existing knowledge for even the most brilliantly endowed person can make but few valuable original discoveries (Stanley 1949 p 455)

Within each generation therefore we can only expect a given indi vidual to internalize meaningfully a reasonable fragment of the total fabric of the culture that is expounded to him by the various educational agencies If we are at all concerned with the breadth of his knowledge we cannot possibly expect him to discover everything he is expected to know The obligation of going beyond one s cultural heritage and contributing some thing new is an obligation that applies to an entire generation not to each of its individual members Hence as we shall see later the school cannot realistically set for itself the goal of having *each* child leap into new and unimagined realms of experience and emerge with ideas that are dis continuous with what went before The school can only hope to help one child in a thousand do this or more likely one child in a million

### *Meaning Is an Exclusive Product of Creative, Nonverbal Discovery*

A related proposition that relies somewhat less on flat epistemological assertion and is more naturalistically grounded holds that abstract concepts and propositions are forms of empty verbalism unless the learner discovers them directly out of his own concrete empirical nonverbal experience Another slightly different way of expressing the same idea is to say that Generalizations are products of problem solving and are attainable in no other way (Brownell and Hendrickson 1950 p 119)

The assertion that abstract concepts and generalizations are forms of glib verbalism unless the learner discovers them himself rests we have seen on (a) a misrepresentation of verbal learning as a passive rote phenomenon (b) confusion between the reception discovery and the rote meaningful di mensions of learning and (c) unwarranted generalization to adolescents and adults of children s dependence on concrete-empirical props in comprehend ing and manipulating abstract ideas Meaningful knowledge is not an exclusive product of creative nonverbal discovery For potentially meaning ful *presented* material to become meaningful knowledge the learner need only adopt a set to relate and incorporate its substantive import nonar bitrarily within his cognitive structure

Discovery enthusiasts tend to confuse the act of discovery with the act of understanding H Taba (1962) for example states that the act of discovery occurs at the point in the learner s efforts at which he gets hold of the organizing principles embedded in any concrete instance can see the relationship of the facts before him understands the why of the phenomena and can relate what he sees to his prior knowledge Actually this is a definition of all meaningful learning irrespective of whether it is reception or discovery learning Discovery enthusiasts also tend to deny the transition from concrete to abstract cognitive functioning and insist that mature learners cannot understand an abstract verbal proposition without first relating it to concrete empirical experience and translating it into subverbal terms Thus G Hendrix (1950, p 337) asserts that "a cognitively sophisticated student, who is sufficiently skillful in interpreting sentence structure as well as referential symbols, can read a sentence which expresses a generalization and then construct or find enough examples of his own to make the general ization an organic part of himself—that is, to acquire the subverbal thing prerequisite to meaning of the sentence"

## *Subverbal Awareness Is the Key to Transfer*

We have seen, up to this point, that the reasoning underlying the mystique of discovery as a prerequisite for meaning, has rested either upon bald metaphysical assertion, or upon unwarranted pseudonaturalistic assumptions regarding the *nature of understanding and knowledge* Hendrix tried to fill this theoretical void by constructing a more systematic and so phisticated pedagogic rationale for the discovery method than had been attempted heretofore She did this by adapting to the problem of transfer the time honored labeling theory of the function of language in thought Hendrix denies that verbal

> generalizing is the primary generator of transfer power    As far as transfer power [is] concerned the whole thing [is] there as soon as the non verbal aware ness [dawns]    The separation of discovery phenomena from the process of composing sentences which express those discoveries is the big new breakthrough in pedagogical theory (Hendrix, 1961, pp 292, 290)

The key to transfer,' Hendrix (1947, p 200) states, is a "subverbal in ternal process—something which must happen to the organism before it has any new knowledge to verbalize Verbalization, she asserts further, is not only unnecessary for the generation and transfer of ideas and understanding, but is also positively harmful when used for *these* purposes Language only enters the picture because of the need to attach a symbol or label to the emerging subverbal insight so that it can be recorded, verified, classified, and com municated to others, but the entire substance of the idea inheres in the subverbal insight itself The resulting problem then, according to Hendrix (1961, p 292), becomes one of how to plan and execute teaching so that language can be used for these necessary secondary functions "*without* dam age to the dynamic quality of the learning itself

The principal fallacy in Hendrix' line of argument, as we have seen above, lies in her failure to distinguish between the labeling and process functions of language in thought Furthermore, it should be self evident that discovered generalizations are available for transfer only *if* and not until *after* they are discovered

The unqualified generalization that verbalization of an insight prior to use inhibits transfer, lacks both logical cogency and empirical support

Nonverbal understanding of principles undoubtedly exists, especially in children and unsophisticated adults, as a precursor to some verbal understandings (Hull, 1920, Luchins and Luchins, 1947) This, of course, does not mean that *nonverbal* concept meanings and propositions are actually used in the *generation* of new insights such a feat would be very difficult, as already explained, because ideas that are not represented by words lack sufficient manipulability to be used in any complex type of thought process It merely suggests that a preliminary intuitive (subverbal) stage exists in the *product* of thought when the emerging new insight is not clearly and precisely defined. However, when this product is eventually refined *through* verbalization it acquires thereby much greater transfer power The verbalization of the insight that takes place at this point is actually a later phase of the thought process itself, and is not to be confused with the still later representational process of *naming* verbalized meanings as a result of which the latter meanings become more manipulable for purposes of thought.

Thus several experiments on children's ability to solve transposition and discrimination problems (Spiker and Terrell, 1955, Weir and Stevenson, 1959) show that verbal insights are more transferable than subverbal insights Knowledge of underlying verbal principles also enhances problem solving (Ewert and Lambert, 1932) and the learning of relevant motor skills (Ervin 1960c) and when distinctive verbal responses are available, they tend to facilitate concept acquisition and conceptual transfer Verbal generalization is particularly important for concept attainment in cognitively sophisticated learners (Heidbreder and Zimmerman, 1955) In a well-controlled recent experiment R. M Gagné and E C Smith (1962) demonstrated the facilitating effect of verbalization on the discovery of general principles and their use in problem solving Finally, merely informing learners verbally that previous learnings might be useful in other situations, tends to increase transfer significantly (Dorsey and Hopkins, 1930)

As the child enters school he encounters concepts of much greater abstractness and complexity, for instance, concepts of addition, multiplication, government, society, force, velocity, digestion, that transcend his immediate experience and language ability Before he can hope to acquire a meaningful grasp of such abstractions directly, that is, through direct abstract verbal exposition, he must first acquire a minimal level of sophistication in the particular subject matter area, as well as graduate into the next higher level of intellectual development, that is, the stage of formal logical operations In the meantime he is limited to an intuitive, semi abstract kind of understanding of these concepts which he often finds difficult to verbalize precisely,[2] and even though convincing empirical evidence is still lacking,

[2] It is important to differentiate between the intuitive subverbal insights of the adolescent and those of the elementary school child. Because the latter uses con-

it is reasonable to suppose that preliminary acquisition and utilization of this semi abstract level of insight both facilitates learning and transferability, and promotes the eventual emergence of *full* abstract understanding (Hendrix, of course, would say that *full* understanding was already attained in the semiabstract phase, providing that the understanding was discovered rather than presented She would also insist that the older individual s verbalization of his understanding detracts from its transferability)

Now, assuming for the moment that Hendrix (1947) experimental findings are valid, how can we explain the fact that immediate verbalization of newly acquired subverbal insight apparently renders that insight less transferable than when verbalization is not attempted? First, it seems likely that premature verbalization of nonverbal insight, before such insight is adequately clear, stable, complete, and consolidated further by extensive use, may interfere with its more adequate emergence and consolidation at this level, as well as encourage rote memorization of the marginal and ineptly stated verbal proposition Even more important, however, is the likelihood that a verbally expressed insight—when ambiguous, unstable, unconsolidated, ineptly expressed, and only marginally competent—possesses less functional utility and transferability than the ordinarily more primitive and less transferable subverbal insight that is more adequate in these latter respects This is particularly true in the case of children, because of their limited linguistic facility and their relative incompetence in formal propositional logic.

Drawing these various strands of argument together, what can we legitimately conclude at this point? First, verbalization does more than just encode subverbal insight into words The use of manipulable words to represent ideas makes possible, in the first place, the very process of transforming these ideas into new insights, and the verbalization of emerging subverbal insights into sentences is an integral part of the thought process that greatly enhances the precision and explicitness of its products It therefore makes possible a qualitatively higher level of understanding with greatly enhanced transfer power Second, direct acquisition of ideas from verbally presented abstract propositions, presupposes both that the learner has at

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crete empirical props in relating potentially meaningful concepts and propositions to his cognitive structure, the initially resulting subverbal meanings are *inherently* intuitive (particularistic, semi abstract and semi precise) on *developmental* grounds Thus even if they are verbalized later they can never transcend this intuitive level The adolescent, on the other hand, relates potentially meaningful concepts and propositions to his cognitive structure without the use of concrete-empirical props hence the subverbal meanings that initially emerge are not intuitive on developmental grounds and can be refined—in precision, clarity, explicitness and generality—through the later process of verbalization tained the stage of formal logical operations, and that he possesses minimal sophistication in the particular subject matter in question The typical elementary school child, therefore, tends to be limited to an intuitive, semi abstract awareness of difficult abstractions The older, cognitively mature individual, however, who is also unsophisticated in a particular subject matter area, is able to dispense with the semi abstract phase of awareness rather quickly—as soon as he attains the necessary degree of sophistication, and once he attains it, he probably short circuits the semi abstract phase completely Lastly, premature verbalization of a nonverbal insight, when this latter insight is still incomplete, unclear, and inadequately consolidated, probably decreases its transferability This phenomenon can be explained by means of the general developmental principle, that an ordinarily higher and more efficient stage of development, while still embryonic and only marginally competent, is less functional than an ordinarily more primitive and less efficient phase of development Running, for example, is eventually more efficient than creeping but if a 1 year-old infant had to run for his life, he would make better progress creeping

G Hendrix, however, comes out with somewhat different and more sweeping conclusions from the same set of data First, she regards nonverbal awareness as containing within itself the entire essence of an emerging idea, and insists that language merely adds a convenient symbolic handle to this idea Second, she generalizes children s dependence on a preliminary semi abstract stage of understanding to all age levels, to all degrees of subject matter sophistication, and to all levels of ideational difficulty Actually, this semi abstract stage is highly abbreviated, both for young children learning less difficult kinds of abstractions and for older, cognitively mature individuals working in a particular subject matter area in which they happen to be unsophisticated, and it is bypassed completely when this latter sophistication is attained Finally, she interprets her experimental findings regarding the inhibitory effects of immediate verbalization on the transferability of subverbal insight, as providing empirical *proof* of her thesis that both the substance of an idea and the essential basis of its transfer power are present in their entirety as soon as nonverbal awareness emerges More probably these findings merely show that a relatively clear and consolidated subverbal insight is more functional and transferable than an ambiguous, inept, unconsolidated, and marginally competent verbally expressed idea

Unlike Hendrix, therefore, we may conclude that secondary school and college students, who already possess a sound, meaningful grasp of the rudiments of a discipline like mathematics, can be taught this subject meaningfully and with maximal efficiency, through the method of verbal exposition, supplemented by appropriate problem solving experience, and that the use of the discovery method in these circumstances is inordinately time-consuming, wasteful, and rarely warranted Why, then, do discovery techniques seem to work so well in programs such as the one devised by the University of Illinois Committee on School Mathematics? For one thing, the students entering the program, being victims of conventional arithmetic teaching in the elementary schools, do *not* have a sound, meaningful grasp of the rudiments of mathematics, and have to be re educated, so to speak, from scratch For another, we have a very strong impression that as the program develops, the discovery element becomes progressively attenuated, until eventually it is accorded only token recognition Lastly, stripped of its quite limited discovery aspects, the UICSM approach is a much more systematic, highly organized, self consistent, carefully programmed, ab stractly verbal system of verbal exposition than anything we have known to date in *secondary school mathematics If it proves anything*, the success of this program is a testimonial to the feasibility and value of a good program of didactic verbal exposition in secondary school mathematics, which pro gram is taught by able and enthusiastic instructors, and in its early stages, makes judicious use of inductive and discovery techniques

### *The Discovery Method Is the Principal Method for Transmitting Subject Matter Content*

Educators who are convinced that abstractions are mere glib verbalisms unless independently discovered by the learner, have no other logical alter native than to advocate the use of discovery techniques—in high school and university as well as in the elementary school—as a principal method of transmitting the substantive content of subject matter J A Easley (1958, 1959), for example, argues strenuously for reorganizing, in whole or in part, the curriculum of science, mathematics, and other secondary school and college level *subjects along the lines of inductive discovery* He also insists that nonverbal understanding and application of principles should be required of and demonstrated by students before they are permitted to use them in verbal form

From a practical standpoint, however, it is impossible to consider the pedagogic feasibility of learning by discovery as a primary means of teaching subject matter content without taking into account the inordinate time cost involved This disadvantage is not only applicable to the type of discovery where the learner is thrown entirely on his own resources, but also applies in lesser degree to the contrived' or 'arranged type of discovery Con siderations of time cost are particularly pertinent in view of our aforemen tioned developmental conclusion that *the discovery approach offers no strik* ing learning advantages expect in the very limited case of the more difficult learning task, when the learner is either in the concrete stage of cognitive development, or, if *generally in the abstract stage*, happens to lack minimal sophistication in a particular subject matter field Also, once students reach secondary school and university the time cost disadvantage can no longer be defended on the dual grounds that the time consuming aspects of discovery learning (the need for concrete empirical props) must take place any way and that in any case elementary school pupils cannot be expected to cover a great deal of subject matter Subverbal intuitive techniques have more general applicability during the elementary school period but are also more time consuming and confer a qualitatively inferior type of understanding than does the verbal expository approach which can be successfully employed once students reach the abstract stage of cognitive development

Thus whereas the relatively frequent use of discovery techniques in the transmission of complex and abstract subject matter content can be defended in the elementary school on the grounds that the acquisition and transfer of intuitive insights may possibly facilitate the later acquisition of abstract understanding it is difficult to rationalize the same practice in high school and beyond It is true as already pointed out that the utilization of subverbal insight by older individuals might be temporarily helpful in the early unsophisticated stages of learning a difficult new discipline Nevertheless since discovery methods are incomparably more time consuming than didactic verbal exposition and since the cognitively mature individual does not linger very long in the unsophisticated state that is benefited by prior acquisition of such insights the use of these methods as a primary means of transmitting subject matter content is as unfeasible as it is unnecessary If secondary school and university students were obliged to discover for themselves every concept and principle in the syllabus they would never get much beyond the rudiments of any discipline However as is similarly the case in the elementary school teachers who do not regard completely autonomous discovery as sacrosanct could greatly mitigate the time consuming disadvantage of discovery methods by the judicious use of prompts or hints

Some discovery enthusiasts (Bruner 1960 Suchman 1961) grudgingly admit that there is not sufficient time for pupils to discover everything they need to know in the various disciplines and hence concede that there is also room for good expository teaching in the schools In practice however this concession counts for little because in the very next breath they claim that the acquisition of actual knowledge is less important than the acquisition of ability to discover knowledge autonomously and propose that pedagogy and the curriculum be reorganized accordingly Hence in spite of the formal bow they make to didactic exposition it is clear that they regard the acquisition of problem solving ability as more basic than the acquisition of subject matter There is after all only so much time in a school day If the school takes as its principal function the development of discovery and inquiry skills how much time would possibly remain for the teaching of subject matter?

Discovery methods of teaching are often based on the naive premise that autonomous problem solving necessarily proceeds on the basis of inductive reasoning from empirical data Actually, even young children usually start with some preconceptions or spontaneous models derived from their own experience or from the prevailing folklore Hence when they are supposedly discovering principles inductively, they are really attempting to use empirical experience to confirm their existing preconceptions It is unpromising to base a teaching program on the expectation that children can invent modern scientific concepts, because their spontaneously invented concepts present too much of a block A more realistic approach 'is for the teacher to *introduce* modern scientific concepts (and) follow the introduction with opportunities for the children to discover that new observations can also be interpreted by use of the concept (Atkin and Karplus, 1962)

Still another disadvantage in using a discovery approach for the presentation of subject matter content inheres in the difficulties caused by children s subjectivism and by their exaggerated tendency to jump to conclusions, to overgeneralize on the basis of limited experience, and to consider only one aspect of a problem at a time (Inhelder and Piaget, 1958 Karplus, 1962a and b, Piaget, 1932) It is true that one objective of the elementary science curriculum (to enhance appreciation of scientific method) implies an effort to educate them out of these tendencies But it is one thing to do so as part of a limited laboratory program, and quite another to struggle full time with this handicap as children are required to self-discover everything they have to learn

It is also completely unrealistic to expect that subject matter content can be acquired incidentally as a by product of problem solving or discovery experience, as, it is hypothesized, occurs in the typical activity program or project method Such incidental teaching pays too little attention to graded and systematically organized content, to substantive and programmatic aspects of presentation, and to practice and feedback variables

Finally, one might reasonably ask how many students have the ability to discover everything they need to know Although the ability to understand original ideas worth remembering is widely distributed, the ability to generate comparably original ideas autonomously is manifested by relatively few persons, that is by gifted individuals

In conclusion, after the elementary school years, verbal reception learning constitutes the most effective method of meaningfully assimilating the substantive content of a discipline Problem solving and subverbal methods are developmentally and pedagogically unnecessary and are too time consuming to accomplish this objective efficiently However, the method of verbal reception learning will be restored to its rightful place in classroom instruction only when it is related to relevant but still to-be conducted research on the nature and conditions of long term meaningful learning of large bodies of verbally presented material

### *Problem-Solving Ability Is the Primary Goal of Education*

A fifth proposition underlying the learning by discovery thesis is the belief that the development of problem solving ability is the primary goal of education Implicit in this proposition is the assumption that the objectives involved in developing problem solving ability on the one hand and in acquiring a body of knowledge on the other are more or less coextensive, and therefore that the learner somehow manages to acquire all of the important subject matter content he needs to know in the course of learning how to discover knowledge autonomously Actually however although these two sets of objectives are related and in a sense mutually supportive they are far from being identical Hence it cannot be assumed that methods promoting one objective necessarily promote the other and that the process and goal of education are one and the same thing as Bruner (1961a) claims they are

In the first place quite apart from its frequent usefulness in problem solving the acquisition of knowledge as an end in itself must be considered the major goal of education Despite the fact that a large proportion of what human beings learn in the course of a lifetime has no immediate utility and is not applicable to any pressing problem of adjustment people are nevertheless strongly motivated to learn so that they can better understand themselves the universe and the human condition Much of this kind of knowledge however would have to be dismissed as worthless if utility for problem solving purposes was invariably considered the criterion for designating worthwhileness for learning Hence if we are concerned with the acquisition of knowledge as an end in itself we cannot leave its implementation to problem solving and discovery techniques The use of these techniques as already pointed out furthers the problem solving objective of education but except in the elementary school and under other special circumstances is not very efficient for transmitting subject matter content

Second the actual objective of typical problem solving activity in most individuals is the solution of various everyday problems in living rather than the discovery of ideas or insights sufficiently important to be included in their permanent store of knowledge[3] For as stated previously although

[3] The inductive derivation of concepts and generalizations from diverse instances is an exception to this statement but is only a conspicuous feature of concept attainment during childhood (before a really large quantity of subject matter is incorporated)

the ability *to understand original ideas worth remembering is widely dis* tributed, the ability to generate comparably original ideas autonomously is manifested by only relatively few persons, that is, by gifted individuals It is true, of course, that 'arranged or ' contrived rediscovery would require considerably *less giftedness, but even the use of this expedient on the part of* the relatively more able (if not gifted) segment of the population would be so time consuming as to render learning by discovery an impractical method of learning everything they need to know

*In the realm of educational theory, if not in actual practice, the impact* of Dewey s exaggerated emphasis on problem solving still continues to disturb the natural balance between the transmission of the culture and the problem solving objectives of education Enthusiastic proponents of the discovery *method still assert that* *more basic than the* attainment of con cepts is the ability to inquire and discover them autonomously (Suchman, 1961)

These somewhat extreme value judgments regarding the principal function of the school *inspire, in turn,* correspondingly one sided proposals with respect to curriculum and pedagogy J R Suchman, for example, con tends that the schools must have a new pedagogy with a new set of goals which subordinates retention to thinking Instead of devoting their efforts to storing information and recalling it on demand, they would be developing the cognitive functions needed to seek out and organize informa tion in a way that would be most productive of new concepts' (Suchman, 1961)

The development of problem solving ability is, of course, a legitimate and significant educational objective in its own right Hence it is highly defensible to utilize a certain proportion of classroom time in developing appreciation of and facility in the use of scientific methods of inquiry and of other empirical, inductive, and deductive problem solving procedures But this is a far cry from advocating that the enhancement of problem solving ability is the *major* function of the school In addition, to acquire facility in problem solving and scientific method, it is not necessary for learners to rediscover every principle in the syllabus Since problem solving ability is itself transferable, at least within a given subject matter field facility gained in independently formulating and applying one general ization is transferable to other problem areas in the same discipline Further more overemphasis on developing problem solving ability would ultimately defeat its own ends *It would leave students with insufficient time in which* to learn the content of a discipline, and hence, despite their adeptness at problem solving they would be unable to solve simple problems involving the application of such content Thus although actual practice in the process of formulating and testing hypotheses and in applying general principles to particular problem situations, is necessary for enhancing problem solving ability much teaching for problem solving necessarily involves the efficient transmission of fundamental widely generalizable principles that are clearly understood and can be stably retained

Teaching for critical thinking and teaching for problem solving' are really somewhat grandiose slogans although obviously much more realistic than teaching for creative thinking To be sure the critical thinking and problem solving abilities of most pupils can be improved But this is not the same thing as saying that most pupils can be trained to become good critical thinkers and problem solvers Potentialities for developing high levels of these abilities are admittedly much less rare than corresponding potentialities for developing creativity Nevertheless there are no good reasons for believing that they are any commoner than potentialities for developing high general intelligence Variability in genic endowment is probably responsible for more of the measured variance in critical thinking or problem solving ability than is variability in educational experience

Aptitude in problem solving also involves a much different pattern of abilities than those required for understanding and retaining abstract ideas The ability to solve problems calls for qualities (flexibility resourcefulness improvising skill originality problem sensitivity venturesomeness) that are less generously distributed in the population of learners than the ability to comprehend verbally presented materials Many of these qualities also cannot be taught effectively Although appropriate pedagogic procedures can improve problem solving ability the number of persons who can be trained to be good problem solvers is relatively small in comparison with the number of persons who can acquire a meaningful grasp of various subject matter fields Thus to ignore the latter individuals and concentrate solely on producing talented problem solvers would be educationally indefensible.

Hence a valid distinction can be drawn between doing' and understanding Understanding is a necessary but not a sufficient condition for meaningful problem solving (the kind that involves genuine appreciation of underlying principles—not trial and-error procedures or simply pragmatic rules of practice) Thus pupils can genuinely understand a proposition without being able to apply it successfully in particular problem situations because such application requires additional knowledge skill ability experience or personality traits that are not inherent in the understanding by itself Conversely doing if it is rote or mechanical in nature does not necessarily either presuppose or enhance understanding

Many current writers (Bruner 1961b J A. Easley 1958 Hibbs 1961 Suchman 1961) in the field of science education express the view that the principal objective of science instruction is the acquisition of general inquiry skills of appropriate attitudes about science and of training in the heuristics of discovery Implicit or explicit in this view is the belief either that the particular choice of subject matter chosen to implement these goals is a matter of indifference (as long as it is suitable for the operations of inquiry), or that somehow in the course of performing a series of unrelated experiments in depth, the learner acquires all of the really important subject matter he needs to know Thus, A R Hibbs (1961) states It does not matter whether the student learns any particular set of facts, but it does matter whether he learns how much fun it is to learn—to observe and experiment, to question and analyze the world without any ready made set of answers and without any premium on the accuracy of his factual results, at least in the field of science

*In our opinion, any science curriculum worthy of the name must be* concerned with the systematic presentation of an organized body of knowledge as an explicit end in itself Even if it is relatively superficial and organized on an intuitive basis, as it must be in the elementary school, the science curriculum should make a start in this direction and give the student a feeling for science as a selectively and sequentially organized structure This is no less important than imparting the view that science is a method of inquiry

Another significant difficulty with this approach is that its proponents tend to confuse the goals of the scientist with the goals of the science student They assert that these objectives are identical, and hence that students can learn science most effectively by enacting the role of junior scientist But are the goals of the research scientist and of the science student really identical? *The scientist is engaged in a full time search for new general or* applied principles in his field The student, on the other hand, is primarily engaged in an effort to learn the same basic subject matter in this field which the scientist learned in his student days, and also to learn something of the method and spirit of scientific inquiry Thus while it makes perfectly good sense for the scientist to work full time formulating and testing new hypotheses, it is quite indefensible, in our opinion, for the student to be doing the same thing—either for real, or in the sense of rediscovery Most of the student's time should be taken up with appropriate expository learning, and the remainder devoted to sampling the flavor and techniques of scientific method It is the scientist's business to formulate unifying explanatory principles *in science It is the student's business to learn these principles as* meaningfully and critically as possible, and *then,* after this background is adequate, to try to improve on them if he can If he is ever to discover, he must first learn, and he cannot learn adequately by pretending he is a junior scientist By so pretending he would fail to acquire the minimal degree of subject matter sophistication in a given discipline that is necessary for abstract intellectual functioning in that discipline, much less make original research contributions to science

It is true that some amount of training in the self direction of learning is necessary as preparation for the years when students will no longer be in school But knowing how to find the best material available on a given topic is not the same as discovery learning or even the same as finding and integrating all of the primary sources by oneself For most individuals, at any stage of life, secondary sources typically present interpret, and integrate knowledge

### *Training in the "Heuristics of Discovery" Is More Important than Training in Subject Matter*

Some advocates of the discovery method favor a type of guided practice in the heuristics of discovery that is reminiscent of the faculty psychology[4] approach to improving overall critical thinking ability through instruction in the general principles of logic Once the heuristics of discovery are mastered, they constitute according to J S Bruner (1961a), 'a style of problem solving or inquiry that serves for any kind of task one may encounter Similarly, J R. Suchman s Inquiry Training Program ' is not proposed as a new way to teach science but as a way of teaching basic cognitive skills [that belongs] in the science program and in every other curriculum area that requires reasoning and the formulation and testing of hypotheses (Suchman 1961)

The principal difficulty with this approach as the faculty psychologists discovered is that critical thinking ability can be enhanced only within the context of a specific discipline Grand strategies of discovery, like scientific method do not seem to be transferable across disciplinary lines—either when acquired within a given discipline or when learned in a more general form apart from specific subject matter content This principle has been confirmed by countless studies and is illustrated by the laughable errors of logic and judgment committed by distinguished scientists and scholars who wander outside their own disciplines The only kinds of transfer that have been empirically demonstrated in problem solving situations are the transfer of specific skills, the transfer of general principles, and the transfer of general approach or orientation to a specified class of problems Hence critical thinking cannot be taught as a generalized ability, in practice, it can be enhanced only by adopting a precise, logical, analytic, and critical approach to the teaching of a particular discipline, an approach that fosters appreciation of scientific method in that discipline Also, from a purely theoretical standpoint alone, it hardly seems plausible that a strategy of inquiry, which must necessarily be broad enough to be applicable to a wide range of disciplines and problems, can ever have, at the same time, sufficient particular relevance to be helpful in the solution of the specific problem at hand And from the standpoint of elementary school children, one wonders

[4] The doctrine of formal discipline is still very much alive

whether principles of inquiry pitched at this level of abstraction could be meaningful enough to be used successfully in problem solving

The rapid rate of obsolescence in science is often offered as a rationale for the heuristics of discovery approach to science teaching Since the content of what is taught today will be obsolescent in fifteen years, the argument runs, *students should be taught the process rather than the content* of science Actually the rate of obsolescence in science is vastly exaggerated Although the specifics of science change rapidly, basic principles tend to manifest impressive longevity This argument is also strikingly reminiscent of the objection small boys offer to washing their faces daily, namely, that they will only get dirty the next day Obsolescence is a fact of life that must always be kept in mind, but this does not render futile the assimilation of the current content of knowledge or counsel exclusive attention to the process whereby knowledge is acquired It merely presupposes a readiness to revise those aspects of one's knowledge that gradually become outdated A related argument invokes the allegedly rapid rate of forgetting in school learning Actually, however, meaningfully learned subject matter exhibits impressive longevity—even over a period of years (Ward and Davis, 1938, Tyler, 1930, 1934)

## *Every Child Should Be a Creative and Critical Thinker*

Discovery methods are often rationalized in terms of the currently fashionable slogan that the school s chief responsibility is to make every child (or nearly every child) a critical and creative thinker This incredible notion is based on the highly questionable assumption that all discovery activity, irrespective of degree of originality, is qualitatively of one piece, on a watered down, more 'democratic definition of creativity, broad enough to include *any* type of independent discovery, on the belief that the very multiplicity of human abilities gives every individual a good chance, genic ally speaking, of being creative in at least one area, and on naive clean slate conceptions of human plasticity which maintain that even if a given child has no creative potentialities, good teachers can take the place of missing genes

J S Bruner is an eloquent spokesman for this point of view

> Intellectual activity anywhere is the same, whether at the frontier of knowledge or in a third grade classroom What a scientist does at his desk or in the laboratory, what a literary critic does in reading a poem are of the same order as what anybody else does when he is engaged in like activities—if he is to achieve understanding The difference is in degree not in kind The schoolboy learning physics *is* a physicist, and it is easier for him to learn physics behaving like a physicist than doing something else (Bruner, 1960, p 14)

J R Suchman (1961) also explains that the ultimate goal of his Inquiry Training Program is for children to discover and formulate explanations which represent the causality of a single instance in terms of broad universal principles and generalizations This is the unification of concepts for *which the scientist strives* It can and in our opinion should be the ultimate goal of children s inquiry as well

We will consider in another context the overall plausibility of this proposition It only remains to point out here that from the standpoint of enlightened educational policy in a democracy the school should concentrate its major efforts on teaching both what is most important in terms of cultural survival and cultural progress and what is most teachable to the majority of its clientele As improved methods of teaching become available most students will be able to master the basic intellectual skills as well as a reasonable portion of the more important subject matter content of the major disciplines Is it not more defensible to aim at this realistic goal which lies within our reach than to focus on educational objectives that presuppose exceptional endowment and are impossible of fulfillment when applied to the generality of mankind? Would it not be more realistic to strive first *to have each pupil respond meaningfully actively and critically* to good expository teaching before we endeavor to make him a creative thinker or even a good critical thinker and problem solver?

We are by no means proposing a uniform curriculum and pedagogy for all children irrespective of individual differences By all means let us provide all feasible special opportunities and facilities for the exceptional child But in so doing let us not attempt to structure the learning environment of the nonexceptional child in terms of educational objectives and teaching methods that are appropriate for either one child in a hundred or for one child in a million

### *Expository Teaching Is Authoritarian*

Advocates of the discovery method also take advantage of the opprobrium associated *with authoritarianism* in education to discredit didactic exposition and to further their own cause In doing this they not only rely on the straw man technique of representing a highly exaggerated tell m and drill approach as typical of expository teaching but also assert that expository teaching is inherently authoritarian When a teacher stands in front of a classroom and presents facts concepts and principles he is according to G Hendrix and others behaving in an authoritarian fashion This is presumably so because he is allegedly coercing pupils by the prestige of his position and by his power to dispense reward and punishment into unquestioningly accepting on faith his own version of the truth instead of giving them an opportunity to discover it for themselves Bruner (1961b) puts it this way Insofar as possible, a method of instruction should have the objective of leading the child to discover for himself Telling children and then testing them on what they have been told inevitably has the effect of producing bench bound learners whose motivation for learning is likely to be extrinsic to the task at hand—pleasing the teacher, getting into college, artificially maintaining self-esteem

In the first place, this distressing picture of expository teaching is a bit overdrawn We do not deny that schools and colleges abound in such teachers But this characterization is certainly not true of all didactic exposition, nor is it inherent in the method itself Second there is nothing inherently authoritarian in presenting or explaining ideas to others as long as they are not obliged, either explicitly or implicitly, to accept them on faith Didactic exposition has always constituted the core of any pedagogic system, and probably, always will, because it is the only feasible and efficient method of transmitting large bodies of knowledge The deference to authority implied in accepting already discovered knowledge has been condemned out of all reason If students were required independently to validate every proposition presented by their instructors before accepting it they would never progress beyond the rudiments of any discipline We can only ask that established knowledge be presented to them as rationally and nonarbitrarily as possible and that they accept it tentatively and critically as only the best available approximation of the truth

## *Discovery Organizes Learning Effectively for Later Use*

We turn now to the last four propositions advanced in support of learning by discovery These propositions were recently propounded by J Bruner (1961a) and, taken together, may be said to constitute a proposed psychological, rather than philosophical, rationale for the discovery method First, Bruner hypothesizes that emphasis upon discovery in learning has precisely the effect upon the learner of leading him to be a constructionist, to organize what he is encountering in a manner not only designed to cover regularity and relatedness but also to avoid the kind of information drift that fails to keep account of the uses to which information might have to be put

However, learning by discovery, in our opinion does not *necessarily* lead to more orderly integrative and viable organization, transformation, and use of knowledge It does so only insofar as the learning situation is highly structured simplified and skillfully programmed to include a large number of diversified exemplars of the same principle, carefully graded in order of difficulty But under these circumstances one must in all fairness attribute these latter outcomes to the teacher s or textbook writer s organization of the data from which the discovery is to be made rather than to the act of discovery itself

As a matter of fact *pure* discovery techniques as employed by scholars and scientists could lead only to utter chaos in the classroom Put a young physics student into a bathtub and he is just as likely to concentrate on the soap bubbles and on the refraction of light as on the displacement principle that he is supposed to discover In the UICSM program therefore students are given a prearranged sequence of suitable exemplars and from these they spontaneously self discover the appropriate generalization Elementary school pupils in the Inquiry Training Program are similarly shown a carefully prepared demonstration film illustrative of a given principle in physics and are then permitted to ask questions answerable by yes or no Under both of these conditions pupils are engaging in true autonomous discovery in the same sense that a detective independently solves a crime after a benevolent Providence kindly gathers all of the clues and arranges them for him in the correct sequence This type of discovery is obviously a far cry from the kind of discovery that takes place in research laboratories As J C Stanley observes

> If as a few ultra progressive educators seem to imply education were solely discovery then teachers would no longer be necessary Usually these theorizers are thinking of classroom situations in which the process of discovery resembles an Easter egg hunt or the piecing together of a jigsaw puzzle the participants make discoveries that could hardly have come about without previous structuring of the situation The teacher activity which is involved in setting up good learning situations is as truly a form of instruction as is direct teaching from lesson plans Simply turning children loose without direction and expecting each of them to discover for himself important relationships such as the fact that the first letter of the first word in every sentence is capitalized would probably prove decidedly ineffective and wasteful of time (Stanley 1949 p 455)

Now in making these observations we certainly do not wish to create the impression that we quarrel with the UICSM method of inducing discovery or that we favor the use of raw unselected and unorganized data in discovery programs We quarrel only with Bruners interpretation that the organizing and integrative effects of learning by discovery are attributable to the act of discovery rather than to the structure and organization which are put there by the programmers of such curriculums as the UICSM and the Physical Science Study Committee courses in secondary school mathematics and physics respectively

Concern with the structure of a discipline is certainly not indigenous to the discovery method as H Taba (1962) seems to imply It is also the basis of all modern approaches to expository teaching or reception learning In fact concern with presenting the unifying principles of a discipline is the main substantive rationale of expository teaching The more unstructured discovery methods on the other hand tend to ignore the particular substantive content of a discipline as long as it can be used to further problem solving or inquiry processes In Suchman s Inquiry Training, for example, there is no attempt to present systematically the content of a sci entific discipline Content is largely a matter of indifference, or incidental to the process of discovery Any kind of content is as good as any other as long as it lends itself to discovery and inquiry Hence unsystematic and haphazard sampling of scientific content is characteristic of his Inquiry Training Program

Learning by discovery is not necessarily antithetical to programmed instruction, despite the howls of anguish which teaching machines frequently elicit from discovery enthusiasts True, the more unstructured kinds of discovery methods (for instance, the Inquiry Training Program), which demand more genuinely autonomous (unprompted) discovery on the part of the learner, are incompatible with the ruleg type of programming (Homme and Glaser, 1960) in which a verbal rule is stated at the outset and the learner is then tested on his ability to apply this rule correctly to various relevant examples Advocates of these kinds of discovery methods also prefer to give the learner greater scope for independent thinking than is implied in the use of closely graduated steps in programmed sequences On the other hand, highly structured discovery methods, such as the UICSM which lead the learner to a desired generalization through the use of care fully graded problem examples are quite compatible with a programming technique that follows the same general procedure R M Gagné and L T Brown (1961) recently conducted an experiment in which one group of learners ( guided discovery ) was required to discover a principle after working a hierarchy of problems which reduced the learning task to a grad uated series of sequential steps

### *Discovery Is a Unique Generator of Motivation and Self Confidence*

J S Bruner (1960, 1961a and b) and other discovery enthusiasts (Hen drix, 1961, Suchman 1961) perceive learning by discovery as a unique and unexcelled generator of self confidence of intellectual excitement, and of motivation for sustained problem solving and creative thinking We have already acknowledged that discovery techniques are valuable for acquiring desirable attitudes toward inquiry, as well as firm convictions about the existence and discoverability of orderliness in the universe It is also reason able to suppose that successful discovery experience enhances both these attitudes and convictions and the individual s feeling of confidence in his own abilities On the other hand there is no reason to believe that discovery methods are unique or alone in their ability to effect these outcomes

As every student who has been exposed to competent teaching knows, the skillful exposition of ideas can also generate considerable intellectual excitement and motivation for genuine inquiry, although admittedly not quite as much perhaps as does discovery Few physics students who learn the principle of displacement from expository teaching will run half naked through the streets shrieking Eureka But then again, how many students of Archimedes ability are enrolled in the typical physics or mathematics class? How comparable to the excitement of Archimedes' purely autonomous and original discovery is the excitement generated by discovering a general formula for finding the number of diagonals in an $n$ sided polygon after working problems one through nine in the textbook? And what happens to Archimedes Junior s motivation and self-confidence if, after seventeen immersions in the tub he has merely succeeded in getting himself soaking wet?

Careful study of the psychological experiment cited by Bruner (1961a), by way of illustrating the allegedly unique motivational and inspirational values of discovery methods leaves one no more convinced than one was before Bruner describes a psychological experiment in probability learning with a two-choice apparatus in which the payoff sequence is arranged at random and there is no pattern Some subjects quickly begin to catch on to the fact [and rightly so in this case] that things are happening quite by chance [and] very soon revert to a much more primitive [and empirically more successful] strategy wherein *all* responses are allocated to the side that has the greater payoff Other more trusting and optimistic souls, however, persist in believing that there *is* some pattern to be found in the sequence i e that regularities are discoverable' and hence keep trying one unsuccessful hypothesis after another, in each of which the number of responses given to each side is roughly equal to the proportion of times it pays off

What has all this to do with the subject at hand? asks Bruner

For the person to search out and find regularities and relationships is his environment he must be armed with an expectancy that there will be something to find and once aroused by expectancy he must devise ways of searching and finding One of the chief enemies of expectancy is the assumption there is nothing one can find in the environment by way of regularity or relationship (Bruner, 1961a p 24)

We can thoroughly appreciate the logic of this argument, but we still cannot see what relevance it has for the issue regarding the unique motivational virtues of the discovery method All Bruner is saying here is that, in the absence of a firm conviction about the existence of discoverable regularities in a particular problem solving situation, one will resort to simple trial and-error behavior—just like Thorndike s cats in the puzzle box But why should discovery methods necessarily inspire any more confidence in the existence of discoverable regularities in the universe than the method of didactic exposition which, after all, is dedicated to the presentation and explication of these regularities? It is true that successful discovery experience strengthens such confidence, but unsuccessful experience has precisely the opposite effect—as demonstrated by the resurgence of magical and superstitious thinking that follows in the wake of failure to find patterns of orderliness in nature

### *Discovery Is a Prime Source of Intrinsic Motivation*

A related motivational proposition put forth by Bruner (1961a) states that "to the degree that one is able to approach learning as a task of discovering something rather than learning about it, to that degree will there be a tendency for the child to carry out his learning activities with the autonomy of self reward or, more properly, by reward that is discovery itself" Bruner feels that learning by discovery frees the child from the immediate control of such extrinsic motives as high marks, desire for parental and teacher approval, and a need to conform to the expectations of authority figures In support of this hypothesis, he cites research data showing that early 'overachievers' in school tend to be conformists, to overdevelop rote abilities, and to be deficient in analytic and critical thinking ability

In our opinion, however, there is no existing or necessary association between a discovery approach to learning and intrinsic motivation, on the one hand, and a reception approach to learning and extrinsic motivation, on the other But because of certain cultural influences on personality development in our type of social system, we would tend to postulate precisely the opposite kind of relationship, namely, that discovery learning is more often associated with extrinsic motivation than is reception learning Whether an individual primarily manifests intrinsic or extrinsic motivation in learning it seems to us, is largely a function of two factors (a) how much intrinsic self esteem he possesses, and hence how great his relative need is for compensatory extrinsic status, and (b) the strength of his cognitive needs in their own right, that is his need to acquire knowledge and to understand his environment, as influenced by genic and temperamental determinants and by previous satisfactory learning experience

On these grounds, we would think that a more plausible interpretation of Bruner's data is that it is the learner who is lacking in intrinsic self esteem who develops an overpowering need both for such external symbols of achievement as high grades and teacher approval *and* for the glory and prestige associated with independent discovery in our culture Hence the overachiever is typically a child who is deficient in intrinsic self esteem He relies unduly on rote memorization both because it is the surest route to the high marks and the teacher approval he craves, and because (on account of his anxiety and impaired self esteem) he lacks the self-onfidence to improvise valid evidence of this nature is virtually nonexistent It appears that the various enthusiasts of the discovery method have been supporting each other research wise by taking in each other s laundry, so to speak, that is, by citing each other s opinions and assertions as evidence and by generalizing wildly from equivocal and even negative findings

In view of the apparently sound theoretical reasons listed earlier (under 'Psychological and Educational Rationale of the Discovery Method ) for predicting modest advantages in learning retention, and transferability attributable to the use of discovery techniques these largely equivocal and negative findings are somewhat disappointing In many cases, of course, findings are equivocal simply because of failure to control such other rele vant variables as the rote meaningful the inductive-deductive, the verbal nonverbal and the intra material orzanization dimensions of learning, while varying the reception-discovery factor In other instances, it is quite possible that negative findings are less indicative of inadequacies in the underlying theory than of inadequacies in research design, which unfairly load the dice against the possibility of confirming hypotheses And as far as *long term* curriculum studies are concerned, one might anticipate that any short term advantages accruing from the use of discovery techniques would be more than offset by its time-consuming aspects and the consequent low rate of acquiring subject matter content

## *Long Term Studies*

Despite their frequent espousal of discovery principles, the various curriculum reform projects have failed thus far to yield any research evi dence in support of the discovery method This is not to say that the evi dence is negative but rather that there just is not any evidence, one way or the other—notwithstanding the fact that these projects are often cited in the discovery literature under the heading, research shows For one thing, the sponsors of some of these projects have not been particularly con cerned about *proving* the superior efficacy of their programs, since they have been thoroughly convinced of this from the outset Hence, in many instances they have not even attempted to obtain comparable achievement test data from matched control groups And only rarely has any effort been expended to prevent the operation of the crucial Hawthorne effect ' that is, to make sure that evidence of superior achievement outcomes is attributable to the influence of the new pedagogic techniques or materials in question, rather than to the fact that the experimental group is the recipient of *some* form of conspicuous special attention, that something new and interesting is be ing tried, or that the teachers involved are especially competent, dedicated, and enthusiastic, and receive special training attend expense free conven tions and summer institutes, and are assigned lighter teaching loads.

But even if the sponsors of the curriculum reform movements were all imbued with missionary research zeal, it would still be impossible to test the discovery hypothesis within the context of curriculum research. In the first place, a large number of other significant variables are necessarily operative in such programs. The UICSM program, for example, not only relies heavily on the principle of self-discovery of generalizations but also on an inductive approach, on the problem-solving use of subverbal insight, on abundant empirical experience, on careful sequential programming, and, above all, on precise, self-consistent, unambiguous, and systematic verbal formulation of basic principles. To which variable or to which combination of these variables and the "Hawthorne effect," should the success of this program be attributed? For reasons enumerated earlier in this chapter, we would nominate the factor of precise and systematic verbal formulation rather than the discovery variable. (Students enrolled in the UICSM program learn more mathematics, in our opinion, *not* because they are required to discover generalizations *by themselves*, but because they have at their disposal a systematic body of organizing, explanatory, and integrative principles which are not part of the conventional course in secondary school mathematics. These principles illuminate the subject for them and make it much more meaningful, coherent, and exciting.)

A number of long-term curriculum studies in the older literature are frequently cited as providing empirical support for the discovery method. Using basically identical research designs, T. R. McConnell (1934), C. L. Thiele (1938), and E. J. Swenson (1949) compared the so-called "drill" and "generalization" methods of teaching number facts to second-grade pupils. The drill approach emphasized rote memorization and mechanical repetition of authoritatively presented facts and rules, whereas the generalization method stressed meaningful perception of relationships and derivation of generalizations. Pupils taught by the generalization method also had the added benefit of concrete props in the McConnell study, and of organized grouping of materials in the Swenson study. A well-known study by G. L. Anderson (1949) was also conducted along very similar lines but used fourth-grade pupils.

Needless to say, the generalization method was found to be superior in all four studies, except in criterion situations calling for immediate and automatic recall of knowledge relatively unchanged in form from that learned in the training situation. Much more salient than the discovery variable in each of these studies, however, is the rote-meaningful factor, and in two of the studies, the differential availability to the "generalization" group of visual aids or of organized grouping of learning materials further complicated interpretation of the findings. It should also be remembered that it is precisely in relation to this age group of young learners first entering the stage of concrete logical operations and still completely unsophisticated in a new difficult and abstract subject matter that the efficacy and feasibility of the discovery method are least disputed The time cost factor is relatively unimportant at this age level because time consuming concrete empirical props must be used in any case because large bodies of subject matter cannot be learned through expository teaching anyway and because the semi abstract intuitive understanding of abstract ideas at this stage of development is often facilitated by discovery learning However it would be quite unwarranted to generalize from these findings that meaningful *reception* learning of twelfth grade mathematics is less efficacious than learning by discovery Preliminary findings of the Inquiry Training Program (Suchman 1959 1962) also fail to support the discovery hypothesis

### *Short Term Studies*

The well known Gestalt writings on insightful problem solving by W Kohler (1925) M Wertheimer (1959) K Duncker (1945) and G Katona (1940) are traditionally cited in the discovery literature as supportive of the discovery method of teaching Actually however the Gestalt emphasis on insight deals only with the rote meaningful dimension of problem solving and has no bearing whatsoever on the relative efficacy of the expository (reception) and discovery approaches As pointed out earlier both reception and discovery learning may each be rote or meaningful depending on the conditions under which learning occurs The Gestalt theorists merely insist that the concept of insight is more valid than the Thorndikian trial and error or the Hullian point of view in explaining problem solving behavior that lies within an organism s verbal or subverbal reasoning ability

Kohler s Wertheimer s and Duncker s monographs also do not really report research findings in the usual sense of the term. They are rather elaborate and sophisticated analyses of the nature and conditions of insightful problem solving from the Gestalt point of view which use observations informal experiments anecdotes and demonstrations to illustrate the principles under discussion Katona s studies on the other hand are more genuinely experimental but at the very most demonstrate that understanding *of a principle as opposed to rote memorization leads to superior retention* and transfer One experiment in particular shows that a rotely memorized verbal principle is less transferable to new problems than is mere empirical experience with problems exemplifying the principle in question But this indicates only that understanding of a principle even when unverbalized is more transferable than *rote* memorization It does not suggest

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[5] The research issues related to these studies and some of the implications of the findings are discussed under the heading of prompting and guidance in practice

that newly emerging nonverbal awareness is *always* more transferable than verbal understanding

This latter study by Katona is reminiscent of G Hendrix previously discussed experiment (1917), but Hendrix carried the design and argument one step further She also included another control group of subjects who first acquired *meaningful* nonverbal awareness of a principle, and then attempted immediate verbalization She showed that her experimental subjects, who were sent out of the room while these control subjects were attempting to verbalize nonverbal awareness, were not only superior in transfer power to the control subjects who had merely learned the principle through verbal exposition, but were also superior to this other control group which had acquired nonverbal awareness *prior* to verbalization Hendrix interpreted her findings to mean that the full transfer power and substance of an idea are already present in the emerging subverbal insight, and that this dawning subverbal awareness, when left unverbalized, is *invariably* more transferable than when put into words We have already explained in detail why we think that premature verbalization of insight reduces transferability, and why we believe that verbalization enhances transferability under all other circumstances At this point, we wish only to consider methodological and statistical aspects of Hendrix' experiment.

In reporting her study, Hendrix frankly acknowledged the difficulty of devising both 'a good behavioral test for the achievement of unverbalized awareness," and a suitable test of transfer There was also the formidable problem of deciding "whether subjects were obtaining the correct answers through counting or through applying the generalization" (1947, p 203) With respect to the maintenance of necessary controls, Hendrix freely admitted, furthermore, that it was difficult to prevent communication and discussion among members of the different method groups in the time interval between learning and testing,' and to administer the various tests and experimental procedures without revealing to the subjects that an experiment was in progress (1947, pp 203 204)

In addition to all of these acknowledged measurement, evaluation, and control problems, only 40 subjects were available for all 3 groups, and even this relatively small number was achieved only by pooling results from three very different kinds of experimental populations, for whom a test of homogeneity of variance was not even reported Both the small experimental population, and the undetermined comparability of its three separate components, rendered untenable Hendrix' assumption that random assignment of subjects to the three treatment groups equalized these groups with respect to the influence of the uncontrolled variables

Lastly, the difference on the transfer test between the 'verbal exposition' group and the 'nonverbal awareness group' was only significant at the 12 level, and the corresponding difference between the 'nonverbal awareness group and the group which had verbalized their nonverbal awareness was only significant at the 33 level Neither of these levels of significance is regarded very seriously by either statisticians or educational research workers Taking all of these factors into consideration therefore the experimental foundations for the far reaching conclusions which Hendrix draws from these findings can hardly be considered impressively firm

We come finally to a series of experimental studies in which varying amounts of guidance were furnished to different groups of subjects in problem solving situations C L Stacey (1949) studied the effects of directed versus independent discovery on solving a group of meaningful problems each of which required subjects to identify the one item in a set of five that did not belong He found that active participation and self-discovery were more efficacious for learning than was passive participation involving only recognition or identification of information presented to the learner This finding of course was wholly predictable since the fostering of such complete passivity in problem solving experience as providing the correct answer for each problem as well as the reason for same is self-evidently inadvisable and is seldom if ever practiced today But even so surprisingly enough significant differences were *not* found between these extreme treatment groups on a transfer test

Using similar kinds of material but with college students rather than sixth grade pupils R C Craig (1956) obtained results even less favorable for the discovery method His directed group which received a brief verbal explanation of principles during the training period, learned and retained significantly more principles than did his independent group which had no help whatsoever in the training situation As in the Stacey study however the two groups were not significantly different with respect to mean score on a transfer test J E Kittell s (1957) findings in a similar type of experiment with sixth grade pupils were if anything even more damaging to the discovery cause than were Craig s The group in his experiment which received an intermediate amount of guidance but nevertheless an amount which was somewhat *greater* than that received by Craig s directed group (explanation of principles *plus* organization of materials) was superior in learning retention and transfer to groups receiving either less or more direction Pooling the findings of these three studies therefore the evidence supports the conclusion that in this type of problem solving exercise guidance in the form of providing information about underlying principles facilitates learning retention and possibly transfer more than either the provision of less guidance or the furnishing of specific rules for each of the problems.

G M Haselrud and S Meyers (1958) conducted a coding study with college students which was explicitly designed to rebut the Craig and Kittell findings However their subjects exhibited significantly better learning on problems where the coding rules were given than where they had to be independently derived Furthermore on a delayed transfer test there was *no* difference whatsoever in the number of correct code identifications made for the problems learned originally with the rule given and the problems learned originally by independent derivation of the code Nevertheless on the grounds that the gain from the first to the second test was greater for those problems where the rule had been independently derived the investigators concluded that principles which are independently derived are more transferable than principles for which the rule is given This in our opinion, is equivalent to saying that of two matched race horses trained by methods A and B respectively who are tied at the end of the criterion race the horse trained by method B is *really* superior because at the half way mark he was one lap behind the horse trained by method A but nevertheless caught up to him by the end of the race

Other studies in this area by B Y Kersh (1958 1962) yielded results practically identical to those of Craig Kittell and Haselrud and Meyers on the test of original learning but results opposite to those of Kittell on the delayed retest By using an ingenious research design however Kersh was able to explain this latter finding on the basis of the greater interest and motivation on the part of the independent discovery group to continue practicing the task during the test retest interval Kersh concluded that discovery experience in itself does not enhance understanding or meaningfulness [6]

In another group of studies on the effects of varying amounts of guidance on problem solving either no differences were found between treatment groups or a limited amount of guidance ( guided discovery ) was found to be superior both to no guidance whatsoever or to complete guidance J Moss (1960) I Maltzman E Eisman and L O Brooks (1950) R M Tomlinson (1962) and R H Forgus and R J Schwartz (1957) reported no significant differences in delayed retention and transfer between direct detailed [7] and guided discovery types of learning groups W E Ray (1957) and J D Rowlett (1960) on the other hand found that guided discovery was superior to direct detailed instruction in remembering and transferring principles of micrometer use and orthographic projection In a recent study of programmed learning R M Gagné and L T Brown (1961) reported that a small step guided discovery method of programming

[6] G L Larson (1963) found that at least part of the superior retention of Kersh s discovery group was attributable to the Zeigarnik effect—a tendency to remember more incompleted than completed tasks Craig s (1965) findings suggest that providing continuing tasks and not stating the rule at the conclusion of initial learning rather than *discovery* enhance motivation to learn in this context

[7] A relatively complete explicit step-by step type of guidance

was superior both to the ruleg method and to a large step prompted-discovery procedure[8] B R Corman s findings (1957) were differentiated with respect to the ability level of his subjects highly explicit instructions were most effective with his more able subjects whereas his less able subjects benefited equally from more and less explicit instructions C N Grote (1960) found that the direct-detailed method was superior for high ability students and that the guided discovery procedure was superior for average-ability students in learning a lever principle

The issue of expository teaching versus independent discovery in the learning retention and transfer of principles is still very much in doubt because of the non comparability of the various studies serious deficiencies in research design and the failure to hold constant or take into account rote meaningful inductive-deductive verbalization ability level cognitive maturity subject matter sophistication and motivational variables In general the research findings support E L Thorndike s well known conclusion that refusal to supply information on the ground that the learner will be more profited by discovering the facts himself runs the risk not only of excessive time-cost but also the strengthening of wrong habits (1935 p 147) Providing guidance to the learner in the form of verbal explanation of the underlying principles almost invariably facilitates learning and retention and sometimes transfer as well *Self*-discovery methods or the furnishing of completely explicit rules on the other hand are relatively less effective

The most efficacious type of guidance (guided discovery) is actually a variant of expository teaching that is very similar to Socratic questioning It demands the learner s active participation and requires him to formulate his own generalizations and integrate his knowledge in response to carefully programmed leading questions and it is obviously much more highly structured than most discovery methods with the possible exception of the UICSM Further research is needed to determine whether guided discovery is superior to simple didactic exposition in terms of relative effectiveness for the time cost involved when such factors as cognitive maturity subject matter sophistication and verbal ability are varied. To be definitive such research must also deal with large segments of instructional material and not merely with short term problem-solving exercises in the laboratory

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[8] S M Ervin (1960c) used a similar guided discovery approach in teaching elementary school children the verbal principles underlying various motor performances. The children were helped by leading questions to formulate the principles from their own observations. This method of instruction resulted in greater transfer than did a nonverbal type of guidance

tive structure This latter concept influences him to be differentially aware of certain properties of a house as a stimulus object and to ignore others to interpret the resulting sensory experience in the light of certain preconceived criterial attributes of house and to infer the existence of other attributes that he actually does not experience as sensory impressions but simply assumes are present on the basis of the object s designated membership in the generic category of house

In short because of the influence of concepts within his cognitive structure man experiences a highly simplified schematic selective and generalized conscious representation of reality rather than a complete and faithful sensory representation of it Nevertheless this conscious experience is much more detailed particularistic and idiosyncratic in its denotative *and connotative aspects than the culturally standardized meanings which* its corresponding generic terms have for him and which he actually uses—in acquiring new knowledge (via reception learning) in thinking and problem solving and in communicating with others

### *Consequences of Conceptualization for Cognitive Functioning*

The simplified and generalized representation of reality that is achieved through the existence and use of concepts makes possible the invention of a language with relatively uniform meanings for all members of a culture thereby facilitating interpersonal communication (Vgotsky 1962) Equally important it also makes possible (a) the establishment in cognitive structure of inclusive and generic constructs (and of propositional combinations of them) in relation to which new correlative and derivative meanings can be acquired and retained more efficiently as part of an organized body of knowledge [1] and (b) the manipulation interrelation and reorganization of ideas involved in the generation and testing of hypotheses and hence in meaningful problem solving

By setting up equivalences that is by grouping related items of experience into categories defined by the criterial attributes of their members concepts therefore standardize and simplify the environment and hence facilitate reception learning problem solving and communication Because it is cumbersome and cognitively inefficient to deal with continuously graded events man resorts to categorization responding to heterogeneous objects

[1] It should be recalled at this point that although the first phase of the assimilation process facilitates the acquisition and retention of meaningfully learned knowledge as compared to the fate of rotely learned materials the same trend toward the simplification and generalization of ideas in cognitive structure (by reducing them to a least common conceptual denominator that is to the ideational import of an established anchoring idea) also accounts for the *forgetting* attributable to obliterative assimilation

or events as a class or as members of a class Concepts free thought learning and communication from the domination of the physical environment They make possible the acquisition of abstract ideas in the absence of concrete empirical experience—ideas that can be used both to categorize new situations under existing rubrics and to serve as anchoring foci for the assimilation and discovery of new knowledge Finally the grouping of concepts into potentially meaningful combinations is responsible for the generation and understanding of propositions

## *Are Concepts Related to Physical Reality?*

It would be quite fallacious however to assert that conceptual reality bears no resemblance whatsoever to the real world A more supportable appraisal of the relationship between conceptual and phenomenological reality would be to characterize the former as a selectively schematic version of the latter Out of the many possible and logically defensible ways of delineating categories into which objects and phenomena manifesting certain designated criterial attributes in common can be sorted as members of generically more inclusive classes a given culture chooses a *particular* set of alternatives In this choice distinctive values attitudes toward life social and economic institutions and ways of institutionalizing interpersonal relationships—as well as sheer random decision historical accident and the patterning influence of earlier forms of the language itself—all play significant roles But despite noteworthy intercultural differences in conceptual meanings the impressive degree of cross cultural uniformity in the denotative meanings and syntactic functions of analogous words in different languages clearly indicates the prepotent constraining influence exerted both by similar physical functional and relational properties of objects and events in the real world and by the inherent logic of classification In short conceptual reality is far from being either a capricious or illogical representation of the physical world

Thus the veridicality of a concept—the extent to which it identifies salient and significant aspects of experience with objective reality—is an important dimension of concept generation In formulating new concepts one can choose to focus on criterial attributes that are more or less central more or less subjective more or less characteristic or more or less idiosyncratic The veridicality of a concept determines in large measure its usefulness both in the structure of knowledge and for purposes of learning problem solving and communication

## *Are Concepts Themselves Real?*

The reified notion implicit in classical Greek metaphysics that conceptual meanings or essences of things are axiomatic givens and exhibit a separate existence in their own right, apart from the physical objects from which they are selectively schematized is both scientifically and philosophically unsupportable As abstractions, concepts obviously represent only one of many possible ways of defining a class and enjoy no actual existence in the physical world Psychologically speaking however, concepts *are* real in the sense that (a) they can be acquired, perceived, understood, and manipulated *as if* they enjoyed an independent existence of their own and (b) they are perceived and understood, both denotatively, and in terms of their syntactic functions in much the same way both within a given culture and from one culture to another For example, *culture* itself is an abstraction (concept) that has no independent existence of its own since it consists merely of *modal* attitudes *typical* ways of thinking and *characteristic* ways of institutionalizing interpersonal relationships in a particular society Yet "culture as an entity, is psychologically real Even though it is an abstraction that has no physical reality apart from the totality of the behaviors, attitudes, and values of its individual carriers, the distinctive properties of a given culture (although only statistical abstractions in their own right) constitute reliably identifiable perceptual and cognizable conceptual entities about which there is much consensus of judgment [2] and which also influences the lives of its members in many predictable and uniform ways Further, ' culture as a *generic idea* is a very useful tool both for acquiring and discovering new knowledge

The concept meanings represented in a given language, therefore, may be thought of as both a product or reflection of culture and as a patterning or limiting factor in the cognitive development of the individual carriers of the culture It reflects the idiosyncratic kinds of, and approaches to, categorization, as well as the characteristic attitudes, values, and ways of thinking that prevail in a given culture Once constituted, then, the structure of a language and the conceptual and syntactic categories it contains, definitely influence, in turn the perceptual and cognitive processes of the developing individual He learns to perceive, think and acquire new meanings selectively in terms of the classificatory schemes available to him in his mother tongue, if the latter fails to recognize certain conceptual distinctions, he is greatly handicapped in making them himself Thus, characteristic patterns of thought in a particular culture affect the nature of the language that evolves and the language reciprocally patterns and limits perceptual and cognitive experience and the types of thinking in which individual members of the culture engage

[2] Undergraduate students for example can predict with almost uncanny accuracy the precise degree of orthodoxy or heterodoxy characterizing the mean beliefs of their classmates with regard to detailed issues relating to such controversial areas as theology and immortality (Ausubel and Schpoont 1957)

## Problems in the Acquisition and Use of Concepts

In considering the role of concepts or generic meanings in human cognitive functioning it is evident that two quite different kinds of psychological problems require explanation First there is the problem of how concepts are acquired and the different kinds of psychological processes involved in such acquisition Second there is the equally important problem of how concepts once acquired influence (a) the perceptual categorization of experience (b) the acquisition and retention through reception learning of new conceptual and propositional meanings and (c) meaningful problem solving (discovery learning)

Subsidiary issues requiring consideration include (a) alternative theories regarding the nature and acquisition of concepts (b) developmental changes in acquiring concepts (changes from one age level to another) (c) characteristic sequential changes occurring in the cognitive properties of a given concept from early to late stages in its acquisition *within* a particular age level (d) reasons for discrepancies between the culturally standardized meaning of a conceptual term and the actual meanings it elicits in different individuals (e) different ways of classifying concepts (f) the role of language in concept acquisition and (g) the influence on concept acquisition of such factors as age experience IQ sex the availability of concrete-empirical experience positive versus negative instances relevant and irrelevant experience contiguity and sequence of exemplars learning set opportunities for application and the homogeneity or heterogeneity of exemplars

## Different Ways of Acquiring and Using Concepts

It is obviously one thing to acquire a concept and quite another to use it in categorizing naive sensory impressions in learning related new meanings and in solving problems Let us consider in general terms some of the principal ways in which concepts are acquired and used reserving for later sections more detailed discussion of underlying processes and developmental differences

### *The Acquisition of Concepts*

We have already distinguished in another context between two principal types of concept acquisition namely concept formation and concept assimilation as typifying respectively the acquisition of concepts among preschool and older individuals

*Concept formation* is characteristic of the preschool child s inductive[3] and spontaneous (untutored) acquisition of generic ideas (for instance house dog ) from concrete-empirical experience It is a type of discovery learning involving at least in primitive form such underlying psychological processes as discriminative analysis abstraction differentiation hypothesis generation and testing and generalization Less typically in real life situations and in the laboratory it is also exhibited by older individuals—but at a much higher level of sophistication with respect to the component psychological processes involved

Most of our information about the nature of concept formation both in young children and in individuals of school age and beyond comes from laboratory type situations in which the learning task calls for the inductive identification of the common criterial attributes of a class of stimuli from a large array of instances which vary in regard to both criterial and non criterial attributes The experimenter for example may present the subject with an array of squares circles and triangles each of which is either red blue or yellow and then say I have a particular idea in mind either a particular form (square circle or triangle) or a particular color (red blue or yellow) Each of the cards in the display in front of you has one of these forms which is colored red yellow or blue You can point to any one of these cards in any order you choose and I will tell you whether it is or is not an example of the idea I have in mind From the answers I give you you will eventually be able to determine which particular idea—one of the three forms or one of the three colors—I am thinking of Your job is to discover this by using as few cards and asking as few questions as possible Let us suppose that the experimenter had a square in mind From his response of yes this *is* an example to red yellow and blue squares and No this is *not* an example to red yellow and blue triangles and circles the subject finally discovers that square is the concept that the experimenter was thinking of

Many other research designs have been used in the experimental investigation of concept formation Only one additional method will be described here This method involves a training session in which the subject first learns the nonsense-syllable names of different classes of stimuli by being presented with different exemplars of each class each exemplar being appropriately labeled with its class name He is then tested for knowledge

[3] As pointed out earlier the use of the term inductive oversimplifies the actual process of concept formation Few problem solving or concept formation situations are approached from scratch—by generating new hypotheses solely from the data at hand More typically the learner approaches new problems by generating hypotheses derived from existing concepts or propositions in his cognitive structure These latter hypotheses may be influenced initially or later on by the distinctive features of the current problem situation

of the criterial attributes of each class by being asked to name correctly other exemplars of these same classes

In real life situations, of course, concept formation is both a more prolonged and less orderly process For example, as a result of being exposed to many different sizes, shapes, and colors of both dogs and other animals, a preschool child eventually acquires a concept of dog that is both generic in nature and a reasonable facsimile of the cultural consensus regarding the nature of the concept in question Both the component psychological processes underlying concept formation, and developmental changes in the cognitive properties of concepts and in the processes involved will be discussed in subsequent sections

Characteristically, however, older (school age) children as well as adolescents and adults, acquire new concepts through a process of *concept assimilation* That is, they learn new conceptual meanings by being presented with the criterial attributes of concepts and by relating these attributes to relevant established ideas in their cognitive structures In the concrete operational stage, as pointed out previously, the assimilation process requires the facilitating influence of concrete empirical props namely, exemplars of the criterial attributes which are related to cognitive structure in conjunction with the attributes they exemplify Learning the meanings of concept names on the other hand, involves a process of representational learning that typically follows concept assimilation itself In other words, these children learn new generic terms either by being presented with their definitions or by encountering them in context—by representationally equating the meanings of new generic terms with the emergent new conceptual meanings in cognitive structure that are elicited by the combination of already meaningful words contained in the terms definitions or contextual cues

Since the necessary definitions and the appropriate context are presented rather than discovered, concept assimilation is typically a form of meaningful reception learning but inasmuch as it still involves various active cognitive operations, it cannot be considered either a passive or perceptual phenomenon In certain instances however where the meaning of a new word is *not* more or less self evident from its context, the learning process is not much different from that involved in concept formation The learner must go through much of the same processes of abstracting differentiating hypothesis generating and testing and generalizing before the new meaning emerges

### *The Use of Concepts*

Once acquired concepts serve many purposes in cognitive functioning At the simplest level of utilization they are obviously implicated in the *perceptual* categorization of incoming sensory experience such as would be involved in perceiving a particular house as an exemplar of the more general class Simple forms of reception learning (where a particular more or less obvious and representational new member of a class is presented as illustrative or supportive of an existing concept in cognitive structure) are also reflective of perceptual categorization Still another perceptual use of existing concepts in cognitive structure is exemplified by the immediate (perceptual) comprehension of the meanings of previously learned and already meaningful concepts and propositions when they are encountered on subsequent occasions

*Cognitive* utilization of existing concepts is exemplified by that type of *reception* learning in which less self-evident exemplars of a known generic class must be identified as such (cognitive categorization) and in which related new concepts subconcepts or propositions are acquired by being assimilated under more inclusive conceptual or propositional entities Meaningful *discovery* learning represents another cognitive use of a learner's existing repertoire of concepts It is exemplified by both (a) simpler kinds of problem solving operations in which solution of the problem at hand merely requires that the learner be able to formulate it as a special case of an already meaningful and more general concept or proposition as well as (b) the more complex kinds of problem solving in which existing concepts and propositions must be extended elaborated qualified or reorganized so as to satisfy the particular requirements of the means-end relationship which the learner is obliged to discover

It is evident from the above discussion that the distinction between the acquisition and use of concepts is in a sense somewhat arbitrary since one of the principal functions of existing concepts in cognitive structure is to facilitate the acquisition of new concepts more so in the case of concept assimilation than in the case of concept formation Nevertheless this distinction is still useful inasmuch as it is consistent with the distinction that has been maintained throughout this volume between the original aquisition of a given item of knowledge and its subsequent use in the acquisition of further knowledge it gets at the very essence of the transfer process and of the central role of cognitive structure variables in this process Furthermore existing concepts are utilized in many ways other than merely in facilitating the acquisition of new concepts namely in the perceptual categorization of experience in problem solving and in perceiving the meanings of previously learned concepts and propositions

It should also be appreciated that problem solving on the one hand and concept formation and utilization on the other overlap in many ways Simple concept formation—both the spontaneous inductive variety in preschool children as well as those atypical instances of concept assimilation in which new generic meanings are acquired through a discovery like process, after being encountered repeatedly in diverse verbal contexts—is actually one type of problem solving Acquired concepts are also used in both simple and more complex varieties of meaningful problem solving to discover new concepts When, for example, the learning of certain presented ideas requires drastic reorganization of existing concepts in cognitive structure (for instance, the formulation of a new concept that is sufficiently inclusive adequately to subsume two or more otherwise irreconcilable presented ideas), the reorganization process constitutes a form of problem solving But this association between problem solving and the formation and use of concepts is by no means invariable Not all problem solving (for instance, maze learning, perceptual motor learning, simple discrimination learning) typically involves the acquisition or use of concepts, and *not* all acquisition and use of concepts (for example, perceptual categorization, simple derivative subsumption, perceptual apprehension of the meanings of previously learned symbols, most instances of concept assimilation and the use of newly assimilated concepts in the reception learning of related new ideas) involves problem solving

Principles differ from concepts in that they involve meaningful relational combinations of concepts that are propositional in nature In other words, a principle, by definition, is a *composite* idea Although many concepts, especially those of a higher-order nature, involve one or more relationships between lower-order concepts ( velocity, for example, involves a relationship between time and distance, and 'acceleration' is a concept in which velocity is related to time) any given concept is only a unitary generic idea

## The Nature of Generic Meaning

A distinction has already been drawn between simple symbols referring to particular objects or events and generic symbols referring to classes of objects Actually, of course, most of the words used in ordinary language, except for proper nouns and such and with the exception of words used by very intellectually immature children, are primarily generic symbols Such words therefore, represent clearly defined concepts with distinctive criterial attributes of their own How then can we explain the generic meanings elicited by the conceptual use of terms in contradistinction to the characteristic kinds of meanings elicited by terms referring to particular objects? Obviously, since the type of meaning experience that emerges, depends on the type of cognitive content that is evoked by the eliciting symbol, the difference between the meaning experiences, elicited respectively by particular and conceptual terms, must be sought in the type of cognitive content each category of term evokes

Thus paralleling the difference in the use of the terms themselves the cognitive content corresponding to a conceptual term is generic rather than particularistic in nature Instead of consisting of a concrete image of a particular object it consists of either (a) a modal or idealized image of a first-order relatively concrete concept such as chair or dog or (b) various combinations of first-order or higher-order conceptual meanings in ways that constitute the criterial attributes of more abstract and complex concepts such as chief of state or chief executive of a republic in the case of president

The generic nature of the cognitive content of conceptual terms naturally reflects the prior occurrence and effects of the distinctive cognitive processes involved in concept formation When a child through hypothesis-generation and testing abstracts for example the criterial attributes of dog from diverse examples of dogs differentiates them from those which are not criterial (or which are criterial of other concepts) and then generalizes the criterial properties to all members of the class it is evident that the resulting cognitive content *has* to be generic in nature The last step in concept formation is establishing representational equivalence between the generic symbol (the concept name) and the generic cognitive content it evokes This is not actually part of the concept formation process itself but is an example of *representational* learning that occurs *after* this process is completed

### *Concept Assimilation versus Concept Formation*

In most instances of concept attainment after early childhood particularly in the school environment the criterial attributes of concepts are not discovered inductively through a process of concept formation but are either presented to learners as a matter of definition or are implicit in the context in which they are used Concept attainment therefore largely becomes a matter of concept assimilation

Since the older learner of school age and beyond does not typically acquire a given concept through such processes as abstraction differentiation and generalization where does the potential generic meaning expressed in its presented criterial attributes come from? Evidently when an individual learns the meaning of a new concept as a consequence of didactic exposition its corresponding generic cognitive content implicitly reflects the previous occurrence of these latter processes in the historical evolution of the language That is since his cultural forebears did the abstracting differentiating and generalizing for him in evolving the concept (namely in discovering its criterial attributes) its symbolic term subsequently elicits generic cognitive content after he currently assimilates the presented criterial attributes in question

Thus in concept assimilation, just as in concept formation, the learner's representational equation of a particular arbitrary term (the concept name) with its corresponding generic meaning for him, is merely a form of representational learning that follows the concept attainment process. The more crucial preliminary operation, whereby the learner acquires the new conceptual meaning through reception learning involves the acquisition of the new generic content itself. The most significant aspect of the concept assimilation process, in other words, involves relating in nonarbitrary, substantive fashion, to relevant established ideas in the learner's cognitive structure the potentially meaningful generic content contained in the term's definition or contextual cues (its criterial attributes). The phenomenological emergence of the new generic meaning in the learner is a product of this interaction. It reflects both (a) the actual content of the new concept's criterial attributes and of the anchoring ideas to which they are related and (b) the kind of relationship (derivative, elaborative, qualifying, or superordinate) established between them.

The acquisition of concepts by reception learning is not simply a process of passive absorption. It is true that there is not the same kind of intensive discriminative analysis, abstraction, generalization, and differentiation as in concept formation; this is precluded by the presentation to the learner of the concepts' criterial attributes. Nevertheless concept assimilation is typically characterized by an active process of relation to, differentiation from, and integrative reconciliation with existing relevant concepts. The more active this process is, the more meaningful and useful assimilated concepts are.

As we shall see later, concepts acquired by assimilation undergo both contemporaneous and developmental change. The former change encompasses the modifications in meaning that occur over the relatively brief time span during which the concept is first acquired and then consolidated. The latter change, on the other hand, reflects the long-term effects on concept meaning wrought by developmental alterations in cognitive functioning and by increasing subject-matter sophistication. These effects, as L. S. Vygotsky (1962) notes, are reciprocal in nature, that is, systematic instruction in concepts influences as well as reflects developmental changes in cognitive functioning. P. S. Freyberg (1966) has shown that the level of concept development, expressed in Piagetian terms, correlates more highly with mental than with chronological age. When measures of this level are combined with mental age, the combined score accounts for a significantly larger portion of achievement test variance in spelling, arithmetical computation, and arithmetical problem solving than does mental age alone.

It should be borne in mind that principles of concept formation, based on laboratory studies, are not necessarily coextensive with or even analogous to principles of concept assimilation in mastering subject-matter material.

In the first place the kinds of variables influencing the processes involved in conceptualization and thus underlying the *discovery* of the criterial attributes of concepts are quite different from the kinds of variables influencing the meaningful *reception* learning of the same criterial attributes Second it presumably should make some difference whether the learning task involves merely the short term acquisition of single somewhat contrived concepts in a laboratory setting or whether it involves the long term acquisition of a complex network of interrelated concepts characterizing an organized body of knowledge The principles of concept assimilation that are relevant to school learning are essentially the same principles of meaningful verbal reception learning discussed in earlier chapters In learning a new concept as much or more depends on existing properties of cognitive structure on the developmental status of the learner and on his intellectual ability as on the nature of the concept itself and the way in which it is presented

## Other Theoretical Views of Concept Acquisition

According to most neobehavioristic theorists (Goss 1961b Osgood 1953 A W Staats 1961) a concept is nothing more than a *common response* to a class of objects or situations presenting some common attributes Neobehaviorists would say that a concept exists for example when different kinds of dogs elicit the same overt or implicit response and when this response is different from that evoked by cats The heart of their view is that the entire class of objects or events constituting a concept evokes the same common *mediated* response typically implicit or verbal Hence a given term that is experienced repeatedly and continuously with different exemplars of the same significate would eventually come to elicit this common response and thus would exhibit *conceptual or generic properties*

The principal difficulty with this view of course is that it posits no differentiated cognitive content of a generic nature to account for the denotative generic meaning elicited by a conceptual term Even the common response which is allegedly the carrier of conceptual meaning has no generic properties in and of itself it is merely evocable by variable members of a class of significates sharing common attributes The theoretical difficulties that arise—in accounting for the denotative aspects of meaning and for the explicit and sharply delineated content of awareness evokes by a meaningful symbol—when meanings generic or otherwise are not referable to differentiated content in cognitive structure have already been discussed

A second difficulty is that although not allowing that concepts are products of certain distinctive cognitive processes (for instance abstraction differentiation, generalization) neobehaviorists fail to specify satisfactory alternative mechanisms whereby concepts acquire their *generic properties* Since the criterion of concept acquisition does not involve any generic *cognitive content*, only requiring a common response to a family of stimuli, conceptual behavior, from a neobehavioristic standpoint, is nothing more than a differentiated conditioned response that is generalized to a class of stimulus *objects having identical elements* That animals and infants are capable of such behavior is perfectly clear It is less self evident, however, why such behavior should be equated with concept acquisition, inasmuch as it does not reflect the essential conceptualizing operation of abstracting criterial attributes from *perceptually unrelated* exemplars of a category The neobehavioristic *explanation, in other words, cannot account for the in* clusion in a concept of *physically dissimilar* exemplars of the class

Information theory (E B Hunt, 1962) rejects the conditioning para digm *of the neobehaviorists and their mediating responses It substitutes* instead computer like ' information processing units which serve as medi ators by operating on positive exemplars of a concept by means of designated rules for decision making The limitations of this approach have already been considered in another context

## *Sequential Stages in Concept Acquisition*

Concept formation consists essentially of a process of abstracting the essential common features of a class of objects or events that vary con textually, in other noncriterial respects, or along dimensions other than the particular ones under scrutiny Typically these "common features" are not *discrete elements shared by a number of stimulus patterns*, but are compar able configurations or sets of relationships Component psychological processes involved in the most highly developed form of concept formation include the following, more or less in the sequence given (a) discriminative analysis *of different stimulus patterns*, (b) the formulation of hypotheses *regarding abstracted common elements*, (c) subsequent testing of these hypotheses in specific situations, (d) selective designation from among them of one general category or set of common attributes under which *all of the* variants can be successfully subsumed, (e) relation of this set of attributes to relevant anchoring ideas in cognitive structure, (f) differentiation of the *new concept from related*, previously learned concepts, (g) generalization of the criterial attributes of the new concept to all members of the class, and (h) representation of the new categorical *content by a language symbol that* is congruent with conventional usage The last mentioned form of repre sentational learning that follows conceptual learning has already been discussed, ordinarily it constitutes the final step in concept formation In instances where the verbal symbol is simply learned by rote in the absence of the preceding steps it has no ideational referents and does not represent a genuine concept

In concept formation the learner generates hypotheses or problem solving propositions which aim at defining the abstracted criterial attributes of the concept to be learned To be potentially meaningful a given hypothesis must embody a means-end relationship that is the hypothesized criterial attributes must be exemplifiable in the specific exemplars The actual process of explicitly confirming or disconfirming that such is the case occurs during hypothesis testing Finally the confirmed criterial attributes are related to relevant ideas in cognitive structure and thereby become meaningful that is constitute the meaning of the concept after they have been assimilated

The anchoring ideas in cognitive structure to which the criterial attributes of new concepts are related naturally vary with the abstractness and complexity of the concept in question When the referent of a concept is a perceptible object or event its criterial attributes are related to a common perceptual core of the object or event In the case of a relatively simple but superordinate concept such as vegetable the anchoring ideas at least initially are probably mere exemplars of the class (carrots peas turnips) which are simple concepts in their own right The criterial attributes of the same concept at a later stage of development or of more abstract concepts with nonperceptible referents on the other hand are assimilated by those anchoring ideas to which the set of abstracted attributes ( something edible not tasty but good for you in the case of vegetable ) is relatable

The actual process of concept formation is undoubtedly facilitated by the child s acquisition of the general idea of categorization The development of this insight is similar in nature and in fact is related to the acquisition of the insight that everything has a name The latter insight it will be remembered is an outgrowth of the realization that (a) all significates with approximately the same perceptual core have the same name and (b) significates with basically different perceptual cores have different names Simple naming itself therefore constitutes a primitive (perceptual) or precategorical type of concept formation The more advanced idea of categorization conceivably arises from the gradually-developing insight that adults also use words in a categorical sense that is to include exemplars that do not share a common perceptual core As the child comes into contact with such categorical words as vegetable fruit play work toy and so forth he acquires the insight that a given word can be used to represent a class of significates with perceptually dissimilar core This general insight in turn motivates him first to identify some physically dissimilar exemplars of simple categorical concepts (for instance to discover that carrots peas, and turnips are vegetables) and later to discover the abstracted criterial attributes both of such concepts and of even more abstract generic ideas that have no perceptible referents Once several categorical ideas are actually acquired they obviously serve as models or paradigms for later instances of concept formation

Contemporaneously as a concept is acquired certain characteristic changes gradually take place (Vygotsky 1962) It becomes increasingly less global less impressionistic and less diffuse (S C Fisher 1916) the learner focuses progressively on more salient criterial attributes Generic mental content also tends to be emptied of particularistic attributes and to become more abstract and general in nature The identification of relevant criterial attributes similarly becomes more precise and refined noncriterial attributes are sloughed off and new criterial attributes are added Distinctions from related concepts also tend to become sharper Idiosyncratic and subjectivistic elements become less prominent as the learner s version of the concept comes increasingly to conform to a culturally standardized consensus Lastly new contextual variants of the concept are acquired with the acquisition of greater sophistication in the same and related disciplines (Rowe 1966) Nevertheless unique individual experience still tends to give an idiosyncratic denotative and connotative flavor to most concepts

## Conceptual Terms and Cognitive Content

It is evident that the use of the same conceptual terms by different members of a given culture does not necessarily imply uniformity of the underlying cognitive content The most obvious reason for this variability inheres in the idiosyncratic nature of both experience and of the cognitive structures to which potentially meaningful concepts are related A second reason is more reflective of developmental immaturity Cognitively immature and intellectually unsophisticated individuals have no other choice but to use conventionally standardized conceptual terms with precise generic meanings to represent meanings of their own which may be vague diffuse imprecise under or over inclusive and often only semigeneric or preconceptual in nature

The commonness of misconceptions during childhood may be attributed to several factors First children do not have the cognitive sophistication and the cumulative background of experience necessary for the complete development of many concepts The pressure on children to mouth inadequately understood concepts and at the same time to conceal their lack of understanding further encourages the development and perpetuation of misconceptions Some children who have inordinate intolerance for ambiguity are predisposed toward acquiring misconceptions since they are prone to reduce the threat and discomfort of tentativeness by resorting to premature conceptual closure (Levitt 1953) Second many of childrens misconceptions are derived from erroneous and incomplete information or from misinterpretation or uncritical acceptance of what they read or are told This is especially true in a socially taboo area such as sex which has both a rich folklore and a special mythology for children Such misconceptions are highly resistive to extinction since they tend to be insulated from the corrective influences of social verification Still another group of childhood misconceptions can be traced to confusion between words with different meanings that either look or sound alike

Since there is often a time lag between the correction of misconceptions and the revision of language usage it cannot be assumed that conceptual confusion necessarily exists in all instances where words are used inappropriately On the other hand some instances of incorrect diction that seem to be largely linguistic in origin may have a conceptual basis The common tendency for children to use tell instead of ask for example may indicate lack of cognitive appreciation of the distinction involved rather than a mistake in concept naming It may also indicate that although some ego expansive children appreciate the distinction they conceive of themselves as telling in situations where others would be asking

## Classification of Concepts

Perhaps the most important distinction that can be drawn among concepts is that between the conjunctive and disjunctive varieties In the case of *conjunctive* concepts *all* of the essential criterial attributes must *always* prevail All of the criterial attributes of *disjunctive* concepts on the other hand need not always be present or may be present in varying degrees they are in other words either or in nature (for instance a real number is either a rational number or an irrational number) A third type of concept *relational* it sometimes recognized it however is really only a subtype of the other two major categories since many conjunctive and disjunctive concepts are characterized by relational attributes Disjunctive concepts are understandably much more difficult to acquire than are conjunctive concepts (Bruner Goodnow and Austin 1956 Wallace and Sechrest 1961) Concepts also vary in complexity in breadth or inclusiveness and in degree of abstractness (the tangibility or perceptibility of their referents)

## Strategies in Concept Formation

J S Bruner J J Goodnow and G A Austin (1956) have indentified various strategies used in the inductive acquisition of conjunctive concepts

In *conservative focusing,* the subject begins with one typical exemplar and then successively searches for other exemplars, one at a time, that are similar in all respects but one In this way he gradually distinguishes between those attributes that are criterial and those that are not Progress is relatively slow but little risk is involved In *focus gambling,* the procedure is very much the same except that the subject successively looks for exemplars that change more than one attribute at a time This strategy naturally involves more risk but leads correspondingly to more rapid progress Successive *scanning* is the most risky strategy Here the subject attempts to choose in one operation an entire series of exemplars, each containing the correct combination of criterial attributes

Under conditions of high cognitive strain,—when there is considerable pressure to attain a concept quickly, the tendency to use risk taking strategies understandably increases Irrespective of the strategy employed, however, most subjects tend to ignore negative information or to shy away from concept attainment by exclusion (Braley, 1963, Bruner, Goodnow, and Austin, 1956) They rely instead on confirmation of positive instances L S Braley attributes this phenomenon to the greater demands that the use of negative information makes on memory storage The essential difference between positive and negative information is the fact that a positive instance indicates explicitly that at least one of the attributes of the instance is criterial, whereas a negative instance indicates that none of the attributes are criterial Thus, in the first case, knowing that one of a given set of attributes must be criterial, enables one to eliminate as exemplars of the class all later instances that do not exhibit at least one attribute of this set In the second case, knowing that none of a given set of attributes is criterial, merely enables one to eliminate all later instances that exhibit any attribute of this entire set, it furnishes useful information but does not provide a positive "lead as a basis for further search

## Language and Concept Acquisition

The capacity for inventing and acquiring language is one of the most distinctive features of human development It is undoubtedly both a prerequisite for the original development of culture and a necessary condition for the subsequent acquisition by the individual of the complex cognitive, social, and moral products of the culture in which he lives Without language the development and transmission of shared meanings, values, and traditions would be impossible People would be unable to communicate with each other except in face to face situations, individual relatedness to and interaction between groups could not take place in the absence of physical proximity, and all of the countless intellectual, interpersonal, and institutional manifestations of cultural existence that depend on verbal conceptualization would be inconceivable

In many respects the speech behavior of infrahuman organisms resembles that of children in the early stages of language development Thus untutored animals vocalize spontaneously mimic sounds in their environment and communicate effectively with each other Many animals can also be trained to react differentially to different verbal cues to mimic human words and to make appropriate vocal responses to different situations True representational symbolism however in the sense that an arbitrary pattern of stimulation is used to signify the meaning of a totally unrelated and dissimilar referent that may also often be remote and abstract is unknown at the infra human level at most animals use symbols to represent relatively immediate concrete and physically similar referents Verbal conceptualization and the use of symbols to represent ideas that transcend concrete experience are undoubtedly nonexistent at the infrahuman level Furthermore only humans can be said to possess a true (invented) language the symbolic meanings of which are socially rather than genically determined and which manifests an organized syntactical structure

Why only human beings have developed a true language is attributable to several factors First they possess an elaborate vocalizing mechanism capable of great versatility in sound production tend to babble spontaneously as infants and are relatively proficient at mimicry Much more important is their immeasurably greater capacity for representational symbolism for verbal conceptualization and for handling abstract ideas Lastly because they live in cultural aggregations they are able to standardize and perpetuate shared meanings for the verbal symbols they invent

It seems probable that both human infants and infrahuman primates develop rudimentary precategorical concepts that subsume significates with a common perceptual core Because of the absence of language however the processes of abstraction differentiation and generalization are exceedingly primitive Generic meanings largely consist of modal or generalized images abstracted from objects and events that are physically similar Symbols are not used representationally either in the process of conceptualization in the attainment of generic cognitive content or in the labelling of concepts It is largely because of their unique ability to acquire abstract concepts (which itself is so largely dependent on language) that human beings are singularly capable both of meaningful reception learning and of meaningfully solving complex relational problems without coming into direct contact with the objects and phenomena involved The actual roles of (a) representational symbols in facilitating the transformational operations involved in conceptualization and (b) verbalization in refining the product of these transformational operations were discussed in another context. Evidence indicative of the facilitating effect of language on concept acquisition has already been cited

It has already been conceded that intuitive (semi abstract and often subverbal) concepts exist, particularly in childhood, and afterwards in the early unsophisticated stage of acquiring a new discipline[4] Such concepts are intuitive and relatively particularistic in nature because their acquisition is dependent on the availability of concrete-empirical props They are functional for purposes of problem solving and further reception learning, but are not nearly as precise, transferable, or efficient for these latter purposes as are the truly abstract and verbal concept meanings that succeed them As suggested earlier, however, when they precede the later developmental acquisition of their abstract verbal equivalents they often enhance meaningfulness and help prevent rote assimilation of new conceptual meanings

In conclusion therefore, language plays a central facilitating role[5] in the acquisition of concepts In the first place, contrary to J Piaget s (1964) view, language—by virtue of the crucial contributions that both the representational power of symbols and the refining aspects of verbalization make to the process of conceptualization—obviously determines as well as reflects the mental operations (level of cognitive functioning) involved in the acquisition of abstract and higher-order concepts Second, as will be pointed out later, the very process of concept assimilation through definition and context would be utterly inconceivable without language Lastly, language helps insure a certain amount of cultural uniformity in the generic content of concepts, thereby facilitating interpersonal cognitive communication

## Developmental Aspects of Concept Acquisition

General developmental changes in concept acquisition have been largely covered already in considering the concrete abstraction dimension of cognitive development From the pre-operational stage to the abstract operational stage, there are progressive gains in the level of abstraction at which the

[4] Prior to being verbalized new concept meanings also typically exist for a short while on a subverbal level—even in sophisticated older learners These subverbal concepts are less transferable than their verbal successors, except perhaps under conditions of premature verbalization

[5] It should be appreciated of course that language is neither necessary nor sufficient for concept attainment Nonverbal children as well as infrahuman mammals can acquire rudimentary concepts It is also possible to attain a concept without realizing it or giving it a name Even aphasics can utilize concepts in problem solving

process of concept acquisition occurs in the level of abstraction of the con cept meanings that emerge from this process and in the abstractness and complexity of the kinds of concepts that lie within the child s grasp As indicated earlier these changes may be grouped under the three qualita tively distinct stages of cognitive development delineated earlier

During the pre-operational stage the child is limited to the acquisition of *primary* concepts—those concepts whose meanings he learns by *first* ex plicitly relating their criterial attributes to the exemplars from which they are derived *before* relating these same attributes to cognitive structure Generally speaking the first of these two operations is performed during the hypothesis-testing aspect of concept formation It is theoretically possible however and it does occasionally happen that he is presented with the criterial attributes of a new concept but under these circumstances the latter attributes would not be relatable to his cognitive structure unless he were first able to test them explicitly against particular exemplars of the concept In any case since intimate contact with multiple particular exemplars of the concept is necessary for concept acquisition both the conceptualization process itself and its products (the acquired new concept meanings) take place at a low level of abstraction

The pre-operational child s dependence on concrete-empirical experi ence also typically limits him to the acquisition of those primary concepts whose referents consist of perceptible and familiar objects and events (such as dog house ) This is the case because only with respect to such concepts are there both sufficient available exemplars and exemplars at a sufficiently low level of abstraction for him to handle at his level of cognitive maturity When he is an adolescent or an adult he may of course discover new primary concepts whose exemplars are themselves highly esoteric ab stractions but at the pre-operational stage the exemplars of such concepts are neither available nor usable for purposes of concept formation This does not mean that the exemplars of concepts must necessarily be nonrepresenta tional in nature that is consist of actual objects or events Exemplars may also be verbal (consist of concept names) as in the previously cited examples of such low-order superordinate concepts as vegetable and work pro viding that (a) the concepts they represent are known and have perceptible referents themselves ( carrot bean housekeeping nursing ) and (b) the criterial attributes of the superordinate concept whether discovered or presented are explicitly related to them (the exemplars)

The concrete-operational child s acquisition of concepts proceeds at a much higher level of abstraction and yields correspondingly more abstract concept meanings He is able to cope with *secondary* concepts whose mean ings he learns without actually coming into contact with the concrete empirical experience from which they are derived Since such concepts are acquired by assimilation (by reception learning) he is merely presented with their criterial attributes, either definitionally or by context But he does *not* have to first relate these attributes to particular exemplars of the concept before the attributes become relatable to his cognitive structure, he depends instead on the use of concrete-empirical props (exemplars of the *attributes*) It has already been explained why the use of such props implies a much higher level of conceptualizing operation than the corresponding use of exemplars of the concept itself Nevertheless the process of conceptualization is constrained by the particularity of the input data, and typically yields a semi abstract and subverbal type of concept meaning Only the less complex kinds of *secondary concepts, not too remotely removed from the* learner's orbit of personal and vicarious experience can be acquired at this time

The highest level of abstraction in concept acquisition is reached during the stage of abstract logical operations The criterial attributes of complex *and higher-order secondary concepts can be related directly to cognitive* structure without any concrete-empirical props whatsoever, and the emerging products of conceptualization are redefined by verbalization to yield precise, explicit, and genuinely abstract generic ideas

Concepts are generally attained more rapidly and efficiently with increasing age (Rossi, 1964, Yudin and Kates, 1963) In addition, several qualitative trends consistent with the stages delineated above have been adequately established

### *Increased Abstractness and Precision*

One of the most significant developmental trends in concept acquisition *consists of a gradual shift from a precategorical to a categorical basis of* classifying experience, or from a relatively concrete to a truly abstract basis of categorizing and designating generic meanings In the precategorical stage, conceptualization does not proceed beyond the step of discriminative analysis (Bruner and Olver, 1963, A E Goldman and Levine, 1963, Reichard, Schneider, and Rapaport, 1944, Russell and Saadeh 1962, Sigel 1953, Vygotsky, 1962, Wallon, 1952, Werner, 1948) Objects and events are *grouped in terms of their immediately perceived properties* rather than in terms of their class membership Thus preschool children are likely to classify objects on the basis of nonessential, incidental features spatial and temporal contiguity, or similarity of action and location During the elementary school years similarity of structure and function becomes a more important classificatory criterion With advancing age, however as the child approaches adolescence, and as he becomes verbal directed and freed from *dependence on concrete* empirical experience in his conceptualizing operations, *categorical* classification on the basis of abstract criterial attributes becomes the dominant mode of organizing experience

At first concrete images are employed to represent a general class of perceptible objects But these are gradually replaced by more abstract representational symbols detached from the stimulus properties they signify (Malrieu 1955 Piaget 1950 1954b Werner 1948) Various dimensional properties (for instance size form color) also tend at first to be restricted to the particular objects in relation to which they are originally experienced With increasing age they become conceptualized and attain independent status in their own right They can then be applied to any relevant object or situation Concomitantly new and more inclusive higher-order abstractions tend to be formed out of existing first-order concepts (Bruner and Olver 1963 Piaget 1950 Welch 1940)

It is clear therefore that concepts are cumulative precipitates of cognitive experience and that later meanings are not only built upon but absorb earlier and simpler ones (Strauss 1952) Conceptual development involves a continuous series of reorganizations in which existing concepts are modified as they interact with new perceptions ideational processes affective states and value systems Increasing cognitive sophistication also leaves its mark on conceptualization Concepts become more elaborate systematic and flexible (Schuessler and Strauss 1950 Vinacke 1951) and less diffuse syncretistic and subjectivistic (Spiegel 1950 Vinacke 1951) Older children for example are less disposed to regard conceptual opposites (for instance ugliness and beauty) as reified entities than as opposite ends of a conceptual continuum They not only generate concepts of much greater scope and inclusiveness but also make finer distinctions between closely related concepts (for example dog and wolf') In the same way subconcepts develop within concepts ( terrier and beagle within dog')

It is important to appreciate that children s use of culturally standardized conceptual terms does not necessarily imply that these terms represent the same generic meanings that they do for adults in the culture The difficulty arises from the fact that children have no other terms to represent their immature conceptualizations and hence are obliged (and are encouraged) to use prevailing linguistic terms Thus dog to a toddler is typically a proper noun (rather than a concept) designating one particular dog and Daddy does not refer to an adult male who is paternally related to him but rather to the most familiar adult male in his social environment. Later on as the child attempts to generalize his existing concepts to new experience dog represents *any* quadruped and Daddy *any* adult male Generalization or extension of use occurs on the basis of the objective affective or functional similarity of a new object or situation to the object or situation originally designated by the word in question (Lewis 1951) Typically this extension is over inclusive and requires differentiation and restriction to a much lesser extent it is also under inclusive and requires widening After the true criterial attributes of a class are properly abstracted over inclusive applications are appropriately restricted and under inclusive applications are appropriately extended Developmentally speaking therefore this problem is one of fitting conventional symbols which have culturally standardized generic meanings to individual cognitive experience until symbol concept relationships for the individual come to approximate corresponding relationships holding for the culture at large

R Brown (1958a) points out that the development of concepts does not necessarily proceed from the concrete (subordinate) to the abstract (superordinate) To the extent that part of the process of conceptual development consists of differentiating subconcepts out of more inclusive categories (for instance carp and perch out of fish ) this contention is undoubtedly valid Nevertheless it must be appreciated that fish to a toddler is not the same superordinate concept that it is to an adult Actually at first it is not a concept at all but rather a particularistic term referring to one or more exemplars of fish and later before a categorical concept emerges the basis of classification is a common perceptual core Thus before subconcepts can be truly differentiated from a more inclusive concept the latter itself must first be acquired by a conceptualizing process in which concrete (precategorical) criterial attributes are progressively replaced by attributes that are more abstract or categorical in nature

### *More Concept Assimilation and Less Concept Formation*

Paralleling general trends in cognitive development reception learning gradually becomes ascendent over discovery learning in the acquisition of concepts Beginning with the child s entrance into school an increasing proportion of his concepts are acquired by definition or use in context But it is only as he approaches adolescence that such nonspontaneous concepts manifest true categorical and generalized meaning Prior to this time (during the stage of concrete logical operations) they are still somewhat particularistic and intuitive in nature because of their dependence during acquisition on concrete empirical props

It is not difficult to understand why concept assimilation gradually becomes the predominant mode of concept acquisition once the child reaches school age whereas concept formation although possible at any age level is generally speaking most characteristic of the pre operational or preschool stage of cognitive development Concept assimilation characterizes the acquisition of secondary concepts it presupposes sufficient intellectual maturity to relate to cognitive structure the abstracted criterial attributes of a new generic idea even though they (the attributes) are *not* first in intimate association with the multiple particular exemplars of the concept from which they are derived Since this degree of maturity does not exist before school age, and only does then when the child has the benefit of concrete empirical props the principal alternative open to the preschooler is to discover the criterial attributes of concepts by himself, using the necessary conceptualizing operations of abstraction, differentiation, hypothesis generation and testing, and generalization In so doing he is obviously limited to the more simple kinds of primary concepts whose referents are either perceptible and familiar objects or events, or known concept words that represent such referents But the criterial attributes of a concept that are discovered through concept formation obviously meet the developmental conditions for relatability to cognitive structure, inasmuch as they have been abstracted from and tested against particular exemplars of the concept during the process of conceptualization Hence there is no problem with respect to the potential meaningfulness of criterial attributes that he discovers by himself

However once the child can meaningfully relate to his cognitive structure the criterial attributes of a new concept without first relating them to multiple particular instances that exemplify it he can acquire concepts much more efficiently By the time he reaches this stage of development, he has also already acquired for the most part, the available supply of primary concepts with familiar and perceptible referents He would thus find it relatively difficult to discover by himself (to acquire by concept formation) the more abstract and complex concepts he attains relatively easily through concept assimilation Hence after discovering the body of simple everyday concepts that are available to them when they enter school, most individuals discover very few concepts by themselves thereafter Contributions to culture's store of more difficult concepts are made by its more gifted members over the course of generations, and become readily available to all other adequately mature members through concept assimilation

During the elementary school years it thus appears that progressive development of the ability to *assimilate* concepts depends on the same three aspects of cognitive and language development that generally bring about the transition from concrete to abstract cognitive functioning (a) gradual acquisition of an adequate working body of higher-order abstractions that provide the component properties and relational elements constituting the criterial attributes of more difficult concepts, (b) gradual acquisition of "transactional terms, that is of substantive words such as state,' 'condition basis property, quality, and relationship" and of functional or syntactical terms such as conditional conjunctives and qualifying expressions that are necessary for bringing abstractions into relationship with each other in ways characteristic of the dictionary definition of new concepts, and (c) gradual acquisition of the cognitive capacity itself, that makes possible the relation of abstract ideas to cognitive structure without the benefit of concrete-empirical props

It is important to recognize and take account of the highly significant interaction that takes place between many assimilated concepts and their subverbal or intuitive precursors As L S Vygotsky (1962) notes, the elementary school child, in acquiring assimilated concepts, is greatly assisted by the existence in his cognitive structure of analogous spontaneous concepts at the pre operational level which he uses nondeliberately and with relatively little cognitive awareness[6] These provide a springboard for the acquisition of "scientific concepts[7] and for their 'downward exemplification and everyday reference But although these spontaneous concepts undoubtedly enhance the meaningfulness of their analogous assimilated counterparts, and probably discourage rote reception learning, they may also, because of their primacy and vividness, interfere with the learning of more precise and categorical criterial attributes The same kinds of relationships also undoubtedly prevail between the more precise and abstract concepts acquired at the secondary school level and their more intuitive elementary school precursors

In teaching scientific concepts therefore, it is essential to take account of the nature of their spontaneous precursors, that is, explicitly to contrast the two sets of criterial attributes and to indicate why the adoption of the more abstract and precise set is preferable Within the limits imposed by developmental readiness, systematic verbal instruction in abstract concepts at the elementary school level, combined with appropriate use of concrete empirical props, is pedagogically feasible and can greatly accelerate the acquisition of higher order concepts (Arnsdorf, 1961, O L Davis, 1958) It is unnecessary and educationally wasteful to wait for such concepts to evolve spontaneously from direct experience Further, many abstract concepts (for instance, "photosynthesis,' 'ionization') can only be acquired verbally since they are not susceptible to direct experience Other, more concrete concepts ('house,' dog," 'red, "hot ), on the other hand, are practically meaningless in the absence of actual experience with the objects or phenomena in question

### *Increased Awareness of Conceptualizing Operations*

Both J Piaget and L S Vygotsky agree that awareness of the cognitive operations involved in concept acquisition does not develop *until the child* approaches adolescence and has been exposed to considerable systematic instruction in scientific concepts

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[6] Work for example is both a spontaneous concept acquired from direct experience and a more formal abstract concept with precise *criterial attributes*

[7] Vygotsky s term for assimilated concepts in contradistinction to concepts acquired by concept formation ( spontaneous concepts )

In operating with spontaneous concepts the child is not conscious of them because his attention is always centered on the object to which the concept refers never on the act of thought itself

A concept can become subject to consciousness and deliberate control only when it is part of a system In the scientific concepts that the child acquires in school the relationship to an object is mediated from the start by some other concept A superordinate concept implies the existence of a series of subordinate concepts and it also presupposes a hierarchy of concepts at different levels of generality Thus the very notion of a scientific concept implies a certain position in relation to other concepts The rudiments of systematization first enter the child s mind by way of his contact with scientific concepts and are transferred to everyday concepts changing their psychological structure from the top down (Vygotsky 1962 pp 92 93)

Awareness of concept acquisition develops late Vygotsky (1962) believes because it requires awareness of similarity This in turn presupposes a more advanced structure of generalization and conceptualization than awareness of difference Nevertheless even though a child cannot use a word like because deliberately in a test situation and does not really grasp causal relations except in a very primitive and intuitive sense he is able to use because correctly in everyday conversation The rules of syntax too can generally be employed correctly by young children despite complete lack of awareness of the nature of these rules However deliberate use of such words as because is possible in relation to scientific concepts because the teacher working with the pupil has explained supplied information questioned corrected and made the pupil explain (Vygotsky 1962 p 107) It is hardly surprising therefore that awareness of concept acquisition and deliberate use of concepts arise earlier in relation to scientific than to spontaneous concepts

## Factors Influencing Concept Acquisition

### *Experience, Intelligence, Sex*

By virtue of the very way in which concepts are generally formed it is inevitable that the acquisition of particular concepts is dependent on a rich background of relevant experience (Serra 1953) Concepts in early and middle childhood especially reflect the cumulative impact of first hand concrete-empirical experience over extended periods of time Hence there tends to be a higher relationship between degree of experience (as indicated by school grade and chronological age) and scores on concept tests than between the latter scores and IQ (Deutsche 1937 Vinacke 1951) For this reason also genuine understanding of such concepts as are involved in the appreciation of temporal and sociological relationships cannot be materially increased by exposing children to brief special periods of essentially second hand, verbal practice in school (Eaton 1944, Pistor, 1940) at the very least, systematic didactic instruction using concrete empirical props is necessary. When abstractions are introduced prematurely, some children become quite adept at mouthing them and at the same time, concealing their lack of true understanding. This obviously becomes a fertile source for misconceptions and uncritical acceptance of ideas.

Although superior mental age, in the absence of corresponding life experience (chronological age) provides little advantage in comprehending abstractions, such comprehension is definitely related to IQ *within* a given grade level (Braun 1963, Elkind 1961, Osler and Shapiro, 1961, Osler and Weiss, 1962, Serra, 1953). The correlation between concept scores and either vocabulary or verbal intelligence is higher than the correlation between these scores and nonverbal intelligence (Deutsche, 1937, H. N. Hoffman 1955). *Apart from conditions of actual cultural deprivation, cultural or* social class environment does not have much effect on ability to conceptualize (Deutsche, 1937), but does sensitize the individual to particular areas of conceptual experience. Thus it is likely that conceptual learning ability is not a unitary trait, it varies with differential patterns of experience. Whatever sex differences appear in concept acquisition appear to conform to this explanation (Elkind 1961, L. A. Olson 1963).

### *Heterogeneity of Instances*

Provided that sufficient redundancy or repetition is present to insure adequate unit mastery (overlearning), the defining attributes of a concept are learned most readily when the concept is encountered in a large number of different contexts (Callantine and Warren, 1955, Duncan 1958, Haygood and Bourne, 1964, Hull, 1920, Johnson and Zara, 1960, Lloyd, 1960, Morrisett and Hovland, 1959, Sassenrath 1959, Shore and Sechrest, 1961, C. Stern, 1965, Wittrock and Twelker, 1964). By de-emphasizing the particularity of single or homogeneous instances, multicontextual learning facilitates the abstraction of commonality, strengthens the generality and transferability of the resulting concept, and endows it with greater stability. Small and barely discriminable differences among instances on the other hand, increase the difficulty of concept attainment (Sechrest and Kaas, 1965). In practice the proper balance between heterogeneity and consolidation can be achieved by promoting mastery within a given context or subcategory of exemplars before proceeding to another context.

### *Positive versus Negative Instances*

The weight of the evidence indicates that positive instances lead more effectively than negative instances to concept acquisition (Braley, 1963, Hov land, 1952, Hovland and Weiss 1953 L. A Olson, 1963) In part, this reflects the greater amount and the more explicit nature of the information conveyed by positive instances and the smaller burden they place on memory (Braley, 1963, Hovland and Weiss 1953) More important perhaps is a disinclination on the part of most learners to make use of potentially useful information presented in negative instances and to adopt a strategy of exclusion (Bruner Goodnow, and Austin 1956) J Huttenlocher (1962), as a matter of fact, found that a negative followed by a positive instance was the most effective combination With increasing practice, the initial difference between the relative effectiveness of positive and negative instances tends to become progressively smaller (Freibergs and Tulving, 1961, Fryatt and Tulving 1963) This suggests that teachers should explicitly train pupils to make more effective use of negative instances in acquiring new concepts

### *Relevant versus Irrelevant Information*

Increased salience of relevant dimensions of a concept tends to facilitate concept acquisition whereas an increase in the amount or salience of irrelevant information has precisely the opposite effect (Haygood and Bourne, 1964, O L McConnell, 1964 Rasmussen and Archer 1961, Thysell and Schulz, 1964, Walker and Bourne, 1961) Irrelevant information obviously complicates the task of concept acquisition by increasing the learner s task of identifying relevant criterial attributes As might be readily predicted, relevant information is more effective when it is obvious rather than subtle (Archer 1962, L. A Olson, 1963)

### *Contiguity and Set*

When an entire array of instances is simultaneously available to the learner rather than being presented successively, concept acquisition is significantly facilitated (Bourne and Jennings, 1963, Bourne and Parker, 1964, Bourne Goldstein, and Link 1964, Kates and Yudin, 1964) This effect presumably reflects the avoidance of memory loss and the possibility of closer grouping during the process of abstracting the criterial attributes of a concept A set or orientation to respond conceptually to stimuli also facilitates the acquisition of concepts (Della Piana, 1957, Shaffer, 1961, Siegel and Siegel 1965)

Chapter 16

# PROBLEM SOLVING AND CREATIVITY

PROBLEM SOLVING REFERS to any activity in which both the cognitive representation of prior experience and the components of a current problem situation are reorganized in order to achieve a designated objective Such activity may consist of more or less trial and error variation of available alternatives or of a deliberate attempt to formulate a principle or discover a system of relations underlying the solution of a problem (insight) When the activity is limited to the manipulation of images, symbols, and symbolically formulated propositions and does not involve overt manipulation *of objects, it is conventional to use the term thinking It is clear,* however, that depending on the approach taken, thinking may either employ the method of insight or may be merely an implicit variety of the trial and error procedure Whether insight or trial and error learning is employed in the solution of a particular problem is a function of both the kind of problem involved and of the age prior experience, and intelligence of the subject

Problem solving, of course, involves discovery learning The important distinction between meaningful discovery learning and meaningful reception learning has been discussed both generally, in terms of its wider implications for education, and in more explicit detail in earlier chapters The different pedagogic ways in which these two varieties of meaningful learning can be related to each other in classroom learning and the manner in which they are sequentially interrelated during the different phases of problem solving—in understanding or formulating the problem, in generating a solution and in incorporating the latter solution into cognitive structure—have also been made explicit

*Thus despite the significant differences between these two kinds of meaningful learning—in terms of both underlying process and role in edu* cation—it is important to bear in mind both their interdependence and the commonalities they share in contrast to rote learning Discovery learning is meaningful when the learner nonarbitrarily and substantively relates a potentially meaningful problem setting proposition to his cognitive structure for the purpose of generating a solution that, in turn, is potentially meaningful (relatable to his cognitive structure on the same basis) It therefore implies, under these conditions all of the essential elements that are implicated in meaningful learning generally a meaningful learning set, a logically meaningful learning task and the availability of relevant established ideas in the learner s cognitive structure The distinctive and significant way in which it differs from meaningful reception learning is that the principal content of what is to be learned is not presented to the learner, but must be discovered by him before it can be incorporated into his cognitive structure and made meaningful

## The Nature of Problem Solving

In terms of approach, two principal kinds of problem solving may be distinguished, both of which occur at all age levels The trial and-error approach consists of random or systematic variation, approximation, and correction of responses until a successful variant emerges The insightful approach, on the other hand implies a set that is oriented toward discovery of a meaningful means-end relationship underlying the solution of a problem It may involve either simple transposition of a previously learned principle to an analogous new situation, or more fundamental cognitive restructuring and integration of prior and current experience to fit the demands of a designated goal Characteristically, insightful solutions *appear* to emerge suddenly or discontinuously They are also invariably accompanied by at least some implicit appreciation of the principle underlying the solution of a problem—even if it cannot be successfully verbalized This understanding is demonstrated functionally both in being immediately reproducible upon subsequent exposure to the same problem, and in being transferable to related problems Hence, not only is insightful solution frequently a reflection of transfer or application of relevant established principles to new variants of the same problem, but transferability itself is perhaps the most important criterion of insight Precisely verbalized understanding of a general principle greatly facilitates (through transfer) the solution of particular problems exemplifying it

The utilization of hypotheses is a necessary but not a sufficient condition of insightful problem solving However, it does not, in and of itself provide assurance that an insightful approach is being taken toward solving a par ticular problem Unless hypotheses incorporate means-ends relationships, they may merely represent systematic trial and error elimination of available alternatives The absence of overt trial and error also does not necessarily imply insightful problem solving, trial and error manipulation in this instance may simply be covert or implicit in thought On the other hand, *insightful solutions* are not always complete, perfect or immediate They often appear after a protracted period of inauspicious search consumed in pursuing unpromising leads

Trial and error learning is more or less inevitable in problems where no meaningful pattern of relationships exists or is discernible Hence, it is generally characteristic of motor learning and of the solution of most mazes and complex puzzle box problems It occurs most efficiently when the subject is both aware of the direction and extent of his deviations from the desired solution, and is permitted to execute the necessary correction and approximation by himself Copying for example, is a much more successful way of learning to write than is tracing This does not necessarily mean, however, that either verbal coaching (explicit pointing out of errors, suggesting more effective techniques) or drill aimed at specific disabilities (Lehman and Cole, 1928) is not efficacious in the learning of motor skills As is true of rote discovery learning generally, the occurrence of positive transfer in maze learning is not attributable to the application of relevant, previously learned principles, but rather, to elimination of initial warm up time and to such factors as general familiarity with and orientation to, the type of approach necessary

Insightful problem solving is obviously a type of meaningful discovery learning in which problem conditions and desired objectives are nonarbitrarily and substantively related to existing cognitive structure It involves "going beyond the information given (Bartlett, *1958*, Bruner, *1957*)—transforming information by analysis synthesis hypothesis formulation and testing, rearrangement, recombination, translation and integration As pointed out previously, however, it does not necessarily imply completely autonomous *discovery Typically, as a matter of fact problem* solving in the classroom constitutes a form of guided or arranged discovery

Much that passes for meaningful problem solving is simply a species of rote discovery learning It is exemplified by the ubiquitous 'type problem approach to the teaching of mathematics and science There is nothing wrong of course, with solving problems by genuinely indentifying them as exemplars of a larger class to which certain principles or operations apply —providing that one understands the principles in question, why they apply to the particular case, and the relationship between the principles and the manipulative operations used in the application All too frequently, however, this is not the case In most mathematics and science classrooms the solving of type problems involves little more than rote memorization and application of formulas rote manipulation of symbols and the use of intrinsically irrelevant cues for identifying problems as members of a class

## *Insight Process versus Product*

Insight can be thought of in terms of process or product As product insight refers to certain distinctive characteristics of the end result of meaningful problem solving as process it refers to a distinctive method of or approach to problem solving

Insight as product possesses the following characteristics (a) subjective a pleased feeling of apt discovery of seeing the light or Eureka (b) objective immediate reproducibility and transposability In the first case we are dealing with a largely affective reaction to the learning product in the second case we are specifying what we can do with insight once it is achieved More significant however both for learning theory and educational practice is to indicate how insight is acquired in the first place and how it differs from other types of problem solving

Because of common misconceptions about the nature of insight it might be helpful to summarize this discussion by specifying what it does *not* involve First contrary to Gestalt formulations its emergence depends on more than just the structure of the problem task it is by no means independent of the learner s prior experience Second it rarely appears abruptly and immediately—despite subjective feelings to the contrary More commonly it follows a period of fumbling and search of gradual emergence of a correct hypothesis Thus the emergence of insight is reflective of a process of progressive clarification about means-end relationships in which the formulation testing and rejection of alternative hypotheses plays a crucial and integral role in the appearance of correct solutions Insightful problem solving—like other forms of learning—does not conform to the all-or none paradigm Third an hypothesis oriented approach while characteristic of insightful problem solving does not necessarily guarantee that an insightful approach is being used Hypotheses can be generated on a purely pragmatic or empirical basis without any intention of coming to grips with the basic cause and-effect issues underlying a given problem and they can also lead to successful problem solving without any genuine understanding of why the solution is successful Lastly insightful problem solving does not in any way presuppose *completely* autonomous discovery

In conclusion insight as a process of problem solving distinct from blind trial and-error solution of a problem implies the existence of a *set* oriented toward hypothesis generation and testing for the purpose of understanding the significant means-end relationships in a particular problem The set is not just to vary responses by approximation and correction until a successful variant eventually appears Once the insight emerges, there must be conscious awareness of its *existence, significance, and availability* rather than mere blind advocacy of a successful variant just because it works'—without any understanding of why Ability to verbalize solutions undoubtedly reflects greater original completeness and clarity of insight, both of which are further refined by verbalization itself, it therefore implies greater transferability Unreportability of insight however, does not necessarily imply either lack of awareness or inability to transfer (Griffin and Beier, 1961)

## *Logic and Thought*

A commonly held position in psychology today—particularly among psychologists who have had some philosophical training—is that logic and thought are more or less coextensive and that thought consists of the cognitive exemplification of abstract logical processes in particular individuals It is true that by virtue of his cognitive capacities man has both discovered logic and has learned how to use it in drawing valid interferences from premises and data Nevertheless the position that logic and thought are one and the same constitutes an unwarranted superimposition of an abstract and idealized state of affairs onto the reality of cognitive functioning—it equates thought itself with one of its specialized tools and products Although J Piaget (1957a) explicitly denies that logic and thought are one and the same, both his extreme emphasis upon the purely logical aspects of thought, and the fidelity and symmetry with which the logical operations he identifies in children s thought parallel the formal structure of rules found in logic and mathematics imply greater perceived coextensiveness between logic and thought than he explicitly acknowledges

Actually much thought involves very little logic It is not illogical but *alogical* That is *most persons can be reasonably logical about affectively* neutral issues when the occasion arises for the application of logic, but in *many everyday aspects of thought, the need for and the opportunity of* exercising logic simply do not arise Many of the problems with which human beings are typically confronted either cannot be reduced to terms that are susceptible to logical proof or cannot be solved merely by invoking the application of rules of inference to data It is not implausible to suppose, therefore, that we have somewhat unrealistically oversold the role of logic, and have correspondingly underestimated the role of other factors in typical instances of human problem solving by (a) using the mathematical or logical problem or the scientific experiment as the paradigm for all problem solving tasks and (b) modeling the general operations of thought after the more formal and specialized operations that serve as rules of inference in mathematics logic and science The kinds of insightful problem solving in which human beings engage are both more extensive than the paradigm allows and less abstract formal and rigorous than the model suggests

### Types of Thinking

Conventional distinctions between inductive and deductive and between divergent and convergent thinking tend to be somewhat misleading First as already pointed out it is seldom the case than an individual approaches a problem with no general hypotheses whatsoever to direct the interpretation of data It is a gross oversimplification therefore to insist that when thinking inductively he proceeds from particular instances to generalizations generating hypotheses solely from the data itself At the very most it would be warranted to claim that in inductive thinking both the initial general hypotheses that are generated as well as the final hypothesis that is selected are typically less familiar and less well-established than in deductive thinking Second in most instances of problem solving irrespective of whether it is called divergent or convergent thinking the typical sequence of problem solving operations involves the generation of multiple hypotheses (divergent thinking) followed by the gradual elimination of those hypotheses that are less tenable (convergent thinking)

## The Role of Cognitive Structure in Problem Solving

That existing cognitive structure plays a key role in problem solving is evident from the fact that the solution of any given problem involves a reorganization of the residue of past experience so as to fit the particular requirements of the current problem situation Since ideas in cognitive structure constitute the raw material of problem solving whatever transfer positive or negative occurs obviously reflects the nature and influence of cognitive structure variables

The possession of relevant background knowledge (concepts principles transactional terms available functions ) in cognitive structure particularly if clear stable and discriminable facilitates problem solving (Saugstad 1955 Saugstad and Raaheim 1960) Without such knowledge as a matter of fact no problem solving is possible irrespective of the learner s degree of skill in discovery learning without it he could not even begin to understand the nature of the problem confronting him Still another cognitive structure source of positive transfer inheres in applicable general elements of strategy orientation and set that reflect prior experience with related problems Finally cognitive structure is related to problem solving in a repository as well as in a determinative sense the substantive or methodological product of a problem solving process is incorporated into cognitive structure in accordance with the same principles that are operative in reception learning

*Cognitive structure also provides an abundant source of negative* transfer in problem solving One type of negative transfer reflects the preservation of inapplicable habitual sets *(Einstellungen)* derived from prior experience with similar problems (Luchins 1946) The solution of novel problems obviously requires both improvisation and a search for new directions—a requirement that is often interefered with by a tendency to use the same approach that was found successful in previous problem solving experience (Maier, 1930) The latter experience thus generates both helpful and interfering sets whose relative strength is a function of such factors as primacy, recency, frequency, vividness flexibility, and level of anxiety

A second, related source of negative transfer in cognitive structure is commonly referred to as functional fixedness (Chown, 1959, Duncker, 1945) This term describes an inability to conceive of other possible uses or functions of an object in problem solving because of the pre emptive influence of the more conventional or established use (for instance, the failure to use a pair of pliers as a weight in a pendulum problem) Functional fixedness is increased when the conventional use of an object is experienced first rather than later in the course of a series of exposures (Yonge, 1966), and is reduced by experience with unusual uses during the training period (Flavell, Cooper, and Loiselle, 1958)

A final type of negative transfer in problem solving merely reflects the prevalence of certain general reductionistic trends found in the thinking of most persons within a given culture for instance, conceptualizing problems in terms of single rather than multiple causality, the tendency to think in terms of all-or none and dischotomous (either-or) propositions and the preference for conceiving of variability in categorical, as opposed to continuous, terms

## Language and Thought

The developmental relationship between language and thought is still a controversial and unresolved 'chicken—or egg type of problem It is clear at any rate that language and thought are not coextensive Language can obviously be exhibited without thought and vice versa (Vygotsky, 1962) *Although simpler kinds of reasoning depend merely on relatively concrete* perceptual, and imaginal operations—and are evident in action prior to the emergence of verbal thought—the ability to think in abstract terms obviously requires the use of abstract concepts and symbols, only the most primitive kinds of problem solving are possible without language The role of manipulable representational symbols in facilitating the transformational aspects of thought and the role of verbalization in refining the products of thought have been discussed in another context It is also possible that *premature* verbalization of insight may impair its transferability because incomplete unclear and unconsolidated verbalized solutions are obviously less functional for purposes of transfer than subverbal solutions that are more adequate in these respects

Thus the role of language in the facilitation of thought is very similar to its role in concept acquisition It not only facilitates ideational problem solving (Gagne and Dick 1962) but also the solution of motor and perceptual problems (Egstrom 1961 Ray 1957) Hypotheses can be formulated and tested much more precisely and expeditiously when they are expressed in verbal form

## Alternative Views on Problem Solving

Neobehavioristic theorists (Berlyne 1954 1965 Cofer 1957 Maltzman 1955 Osgood 1957) tend to conceptualize thinking as a complex form of effective habit strength which is produced by mediated generalization (Maltzman 1955) Depending on whether a given stimulus elicits a single response or multiple responses convergent and divergent mechanisms respectively are said to exist Mechanisms that are mediated by a distinctive common response are conceived of as belonging to the same habit family In essence then problem solving is regarded as a temporal sequence of responses connected in chain like fashion through a verbal mediator Unanswered by this theoretical formulation of thinking are such crucial questions as the basic difference between insightful and trial and-error problem solving the role of existing background ideas in cognitive structure the way in which ideas are reorganized in problem solving and the entire problem of conscious awareness of the process and content of thought

Gestalt theorists (Duncker 1945 Katona 1940 Kohler 1925 Wertheimer 1959) deny that thinking is nothing more than the associative chaining of responses emphasizing instead the central role of a reorganization of ideas eventuating in insight According to them the achievement of insight depends solely on the structure of the problem and is an all-or none phenomenon essentially discontinuous with prior unsuccessful trials in a given problem solving experience Insight deals not with items and blind connections between items but with the contents and the results of the operations thus understanding the reasonable inner relations between operations and results is the distinguishing feature of insight (Wertheimer 1959) Wertheimer regards thinking as conforming to an organic rather than a mechanical mode of attack if the learner first defines the goal occurring in concept acquisition Especially in the area of thinking and problem solving, it is important to distinguish between those developmental changes that are qualitative in nature and those that are merely quantitative Despite J Piaget s (Inhelder and Piaget 1958) assertions to the contrary, the weight of the evidence points to the conclusion that *some* kinds of thought processes, logical operations and problem solving strategies are employed at all age levels differing principally in degree or complexity (Burt, 1919, Long and Welch, 1941a and b Welch and Long, 1943, Werner, 1948) For example, equivalence, discriminative, and eliminative logical operations seem to be qualitatively similar at all age levels once they emerge The older child s greater competence in using these operations largely depends on his superior ability to think abstractly and to generalize Similarly the use of trial and-error and insightful approaches to problem solving does not under go qualitative change from one age level to the next Neither approach can be said to be characteristic of children at a designated stage of intellectual development, both are found at all age levels The choice between the two approaches depends mainly, on the intrinsic difficulty and complexity of the problem, on the individual s prior background of exerience and general degree of sophistication in the problem area, and on the susceptibility of the problem to logical analysis and an hypothesis-oriented mode of attack It is true that older children, on the whole, tend more to use an insightful approach, but this is so only because their greater capacity for abstract think ing makes such an approach more feasible

On the other hand certain qualitative changes in thinking do occur with increasing age These are gradually occurring changes in *kind* that emerge after a certain threshold value of change in *degree* has been reached One such change consists of a gradual transition from subjective to objective thought,—of an emergent ability to separate objective reality from subjec tive needs, wishes, and preferences This trend is responsible for the striking decline that occurs during the elementary school years in autistic, animistic, ethnocentric, magical, anthropomorphic, absolutistic, and nominalistic thinking [1]

A second qualitative change in thought is reflective of the transition from concrete to abstract cognitive functioning, and illustrates all of the characteristic features of this transition Because the pre-operational child cannot meaningfully manipulate relationships between secondary abstrac tions, his thought processes are necessarily conducted at a low level of abstraction and also yield products at a correspondingly low level Thus he

[1] Evidence of such thinking can of course, be found at older age levels also but is much less flagrant and tends to occur under more atypical conditions, such as confrontation with unfamiliar phenomena or problem areas

cannot perform many significant logical operations that presuppose a capability of meaningfully manipulating relationships between secondary concepts. As a result of this developmental constraint his thought does not exhibit "conservation" and his problem-solving efforts are relatively dependent both on the overt manipulation of objects and on the internal manipulation of near images.

The concrete operational child can meaningfully manipulate relationships between secondary abstractions and can, therefore, perform those logical operations reflective of this capability. However, he is dependent in so doing on the availability of concrete empirical props (exemplars of the abstractions). His thought processes are thus conducted at a qualitatively higher level than those of the pre-operational child, but are still constrained in their level of abstraction by the particularity inherent in the props he uses. The products of his thought are therefore only intuitive and semi-abstract in nature.

Only in the stage of abstract logical operations, when relationships between secondary concepts can be meaningfully manipulated without any reference whatsoever to particular instances, does the process of thought become genuinely abstract in the fullest sense of the term. The products of such thought can therefore be refined through verbalization to yield ideas that are truly explicit, precise, abstract, and general. The individual at this stage of development is capable of solving problems by formulating general principles in terms of general relationships between all possible and hypothetical combinations of abstract variables.

## *Age Level Trends in Problem-Solving Ability*

The increasing ability of children to solve more complex problems with advancing age has been demonstrated both for trial-and-error learning (Munn, 1954) and for such tests of insightful learning as the double alternation problem (Gellerman, 1931, Hodges, 1954), transposition (Alberts and Ehrenfreund, 1951), other relational problems (Elkind, 1966, Heidbreder, 1928, Roberts, 1940, Wohlwill, 1960a, Yudin, 1966, Yudin and Kates, 1963), inductive and eliminative reasoning (Burt, 1919), and various tool utilization problems (Matheson, 1931). Younger children profit less from hints (Welch and Long, 1943) and are less able to generalize or transpose solutions to more abstract and remote situations (Spiker, 1956, Stevenson and Bitterman, 1955, Welch and Long, 1943). They have more difficulty with problems at higher levels of abstraction (Burt, 1919, Welch and Long 1943), with more complex kinds of reasoning operations (Long and Welch, 1941b and 1942), and with problems demanding the integration of two isolated experiences (Maier, 1936). Much of the superiority of older children in these latter instances inheres in the advantages that the ability to use verbal symbols provides for the process of generalization for generating hypotheses for process information and for employing efficient strategies (Weir, 1961)

### *Age Level Trends in Problem-Solving Approach*

With advancing age as might readily be anticipated, the frequency of overt trial-and-error approaches to problem solving declines (G V N Hamilton 1916 Munn 1951 Nelson 1936) Hypothesis oriented approaches become more evident (G V N Hamilton 1916) and insightful solutions become more complete (Alpert 1928) These trends obviously reflect in part, increasing ability to generalize and to manipulate abstract symbols As K. Lewin (1951) points out they also reflect the widening and greater differentiation of the child's life space In the detour problem for example older children focus less exclusively on the obtrusively obvious barrier and are better able to appreciate that the most direct route to the goal is not necessarily the shortest

Older children are more aware than younger children of the existence of a problem when exposed to one (Heidbreder, 1928) Their plan of attack is more systematic and their solutions tend to be more flexible and less stereotyped and perseverative (Elkind 1966 G V N Hamilton 1916, Lindley, 1897, Maier, 1936 Raaheim 1965) Since their knowledge tends to be organized in terms of more highly systematized inclusive and self consistent categories they adopt a less fragmented approach to problem solving and because they are better able to bring prior experience to bear on a current problem (Maier 1936) they profit more from past mistakes (Lindley, 1897) Younger children on the other hand are limited by their inability to focus on more than one aspect of a problem at a time (Piaget 1952a) by the diffuseness of their thinking (Piaget 1954b) by their low frustration tolerance, and by their reluctance to accept the immutable givens of a problem They are more situation bound and less able to generalize beyond a particular context (Piaget 1950 1954b) Their formulations are more dependent on concrete imagery and the physical presence of objects and derive less benefit from the use of abstract symbols higher-order concepts, and categorical propositions (Piaget 1954b Welch and Long 1943) Finally after solving a problem they are less capable of verbalizing (and hence transferring) the underlying principles (Heidbreder 1928 Piaget, 1954b Roberts 1940)

### *Age Level Trends in the Objectivity of Thought*

The progressive decline in the egocentricity and subjectivism of children's thought is one of the two principal aspects of cognitive development accounting for age level changes in the quality of problem solving The growing child becomes more aware of his own thought processes and better able to distinguish between external reality and his own experience, between 'the sign and the thing signified,' and between thought and the object thought about (Piaget, 1928, 1929) Logical inference becomes less a matter of subjective preference and less tied to autistic premises (Heidbreder, 1927, Piaget, 1928) The more important of these trends can be illustrated by considering changes in subjectivism associated with the child s development of notions of causality

Considered in this light, the evidence regarding stages' becomes less contradictory In support of J Piaget s view, children do seem to pass through gross qualitative stages of causal thinking (Dennis, 1942, 1943, Grigsby, 1932, Mogar, 1960, R W Russell, 1940) and rarely appreciate antecedent-consequent relationships in the adult sense of the term prior to the age of 8 to 10 (Cohen and Hansel, 1955, Lacey and Dallenbach, 1940) Even Piaget's severest critics concede that there is gradual improvement with increasing age in the *quality* of children s causal explanations (Deutsche, 1937, M E Oakes, 1946) On the other hand, much overlapping prevails between age groups All kinds of causal explanations are found at all age levels (Deutsche, 1937, Grigsby, 1932, M E Oakes, 1946, R W Russell, 1940), some adolescents and adults even give responses characteristic of young children (Dennis, 1943, Hazlitt, 1930, M E Oakes, 1946) Furthermore, changes tend to occur gradually and the quality of causal thinking shows much specificity and dependence on particular relevant experience (Dennis, 1942, Deutsche, 1937, M E Oakes, 1946) None of these facts, however, is incompatible with the existence of certain qualitative stages in children s thinking as defined earlier

Externalization and objectification are relatively early steps in the development of ideas of causality (Piaget 1954a) The infant must learn to distinguish between independent systems of cause and effect in the external world and effects attributable to his own volition and action He beings to do this when he appreciates that mere volitional wishing does not satisfy his needs, that parents are mediators of need satisfaction, and that he is executively dependent on them (Ausubel, 1958), but although magical thinking tends to decline with increasing age (Dennis, 1942, 1943, Piaget, 1932, R. W Russell, 1940), it by no means disappears, even in adults (Dennis, 1943, Hazlitt, 1930, M E Oakes, 1946) It does, however, become less naive and more highly formalized, that is, magical properties and powers are attributed more to special words, objects, rituals, and beings, and less to wishing Concomitantly, mechanical and naturalistic interpretations of causality increase, and animistic and artificialistic' interpretations decrease in frequency

By animism J Piaget means the "tendency to regard objects as living and endowed with will" (Piaget, 1929) The related concept of artificialism refers to a type of personification in which creative activity in nature is attributed to some human agency rather than to naturalistic phenomena At first, according to Piaget, the child regards everything that is active, whole, and useful as alive Later, life is attributed only to moving objects The still more sophisticated child applies the criterion of spontaneous movement. Finally, only plants and animals, or only animals, are considered to be alive Other investigators (Huang and Lee, 1945, Klingensmith, 1953) have shown that when a child states that something is 'alive, he mostly means that it is active, and does not necessarily attribute to it the anthropomorphic characteristics of feeling, seeing, knowing, thinking, wanting, breathing, and so forth

Animistic tendencies are also not restricted to children, but are manifested even by educated adults in our culture when required to explain events completely beyond their sphere of experience and competence (Hazlitt, 1930, M E Oakes, 1946) This suggests that the crucial factor in causal thinking is making a judgment of relevance between antecedent and consequent For the unsophisticated child (or adult) antecedence in itself, as well as animistic, magical, and artificialistic connections between antecedent and consequent, seems to be sufficient criteria of relevance (Piaget, 1932) Given the benefit of increased incidental experience and instruction, however, he learns to avoid attributing causal significance to irrelevant and purely temporal antecedents of consequences, and to avoid generalizing the expectation of similar consequences in all situations superficially similar to a particular cause-effect sequence (Ausubel and Schiff, 1954)

## Factors Influencing Problem Solving

Much can be learned about process factors influencing problem solving by comparing the respective performances of successful and unsuccessful problem solvers (Bloom and Broder, 1950) To begin with, successful problem solvers flounder less, they are more decisive in choosing "some point at which to begin their attack" In many instances this simply reflects greater attention to and comprehension of the directions Second, they focus more on the problem to be solved rather than on some irrelevant aspect of the problem Third, they can better bring to bear on the problem the relevant knowledge they possess They perceive more clearly the implications and applicability of their knowledge to the problem at hand, and are less confused by a change in wording or notation Fourth, they exhibit a more active and vigorous process of search Their approach is less passive, superficial, and impressionistic. They tend to apply solutions from previous problems less mechanically. Fifth, they are more careful and systematic in their approach (see also F. M. Duncan, 1964). Their efforts are less haphazard and less characterized by guesswork. Sixth, they tend more to follow through a line of reasoning to its logical conclusion. They are more persistent and less distractible in their performance. Seventh, their attitudes toward the value of reasoning are more positive and less fatalistic. Eighth, they exhibit greater self-confidence in their ability to solve problems and are less discouraged by complexity. Ninth, their approach to problem solving is more objective and impersonal. They are influenced less by affective and subjective considerations (see also Tate and Stanier, 1964). Lastly, they are able to overcome more easily the negative transfer effect of an interfering set (C. P. Duncan, 1959; O. W. McNemar, 1955).

### *Task Factors*

Practice with a variety of problems in a given class tends to enhance transfer in problem solving (C. P. Duncan, 1958). Heterogeneity of exemplars presumably discourages blind preservation, forces the subject to remain alert and attentive, and increases the generality and hence the transferability of a solution. For purposes of transfer, even the presence of irrelevant information is helpful (Overing and Travers, 1966) because it adds variety to the problem task. As pointed out previously, however, the transfer effects of heterogeneity are negative unless mastery within each problem type is achieved.

The development of problem solving ability obviously requires long term experience in coping with problems. For reasons already given, *some* of this experience should be autonomous or unguided. There are good grounds for believing, however, both that guidance in the form of hints facilitates problem solving (see also Burack and Moos, 1956; Maier, 1930; Maltzman, Eisman, Brooks, and Smith, 1956; M. R. Marks, 1951; Reid, 1951), and that it is pedagogically effective in developing problem solving skills. All methods designed to improve pupils' ability to solve problems either rely on certain general hints about efficacious problem solving techniques or provide critical feedback about the strategies employed.

Although research findings are equivocal, concreteness of the problem itself (other factors being equal) appears to be a significant facilitating factor in problem solving (Cobb and Brenneise, 1952; Gibb, 1956). Theoretical considerations suggest that concreteness makes more of a difference in the case of young children and when the problem area is particularly unfamiliar.

Prior experience with a simpler version of the problem (Hoffman, Burke, and Maier, 1963), as well as specific experience with objects in un related situations (Birch and Rabinowitz, 1951), tend to induce negative transfer They apparently establish a perseverative, interfering set related to functional fixedness

*Intrapersonal Factors*

Intelligence is one of the most important determinants of problem-solving ability For one thing, reasoning power is a prominent component of all intelligence tests For another, many other intellectual abilities measured by the intelligence test (comprehension, memory, information processing, ability to analyze) affect problem solving IQ is positively related to both trial and error (Munn, 1954, Nelson, 1936) and insightful problem solving (Gellerman, 1931, Harootunian and Tate, 1960, Munn, 1954) However, for those kinds of problem solving that depend on cumulative incidental experience, for example, causal thinking (Deutsche, 1937) and applications of the lever principle (G M Peterson, 1932), grade in school is a more significant correlate of success than either IQ or socioeconomic status Brightness level also affects approach to problem solving When mental age is held constant in a categorization problem, older (and duller) children adopt a more concrete and less self-consistent approach use more categories, and are more immediate minded' They also find it more difficult to shift from one basis of categorization to another (Kounin, 1943)

It cannot be emphasized too strongly that the possession of relevant background knowledge is an important determinant of problem solving capacity Heuristic skill is no substitute for substantive knowledge in most everyday and academic problem solving tasks This simple principle, however, is frequently overlooked when findings from laboratory studies are uncritically extrapolated to real life situations it is typically forgotten that problem tasks in the laboratory are deliberately selected on the basis of relative independence from antecedent relevant experience Nevertheless, understanding of relevant principles and concepts, while necessary for problem solving is not a sufficient condition, many other cognitive and personality variables are implicated Thus, although successful problem solving unambiguously indicates that understanding is present, unsuccessful problem solving does not prove that understanding is absent.

Other cognitive traits such as open mindedness, flexibility, capacity for generating multiple and novel hypotheses, attentiveness, incisiveness, problem sensitivity, intellectual curiosity, and ability to integrate ideas influence problem solving in rather self evident ways Cognitive style, as suggested previously, is obviously a relevant factor, particularly with respect to general strategies of problem solving Although evidence is lacking, it seems reasonable to suppose that problem solving ability is not a highly generalized trait within a given individual, varying rather on the basis of interest experience, and aptitude in different areas of human endeavor

Sex differences in verbal problem solving (Munn, 1954) and causal thinking (Russell, 1910) are not significant, but boys tend to surpass girls in mechanical puzzle problems (Munn, 1954) and in arithmetical reasoning Motivational traits such as drive, energy level, persistence, and frustration tolerance affect problem solving outcomes in a positive way (A Alpert, 1928, French and Thomas, 1958), but excessive drive or emotionality tends to constrict the cognitive field and to promote rigidity and preservation (Bahrick, Fitts, and Rankin, 1952, Easterbrook 1950) Many temperamental and personality traits such as high kinetic level, decisiveness venturesomeness, self confidence, and self critical ability (A Alpert, 1928, Kempler, 1962) facilitate problem solving when present in a moderate to high degree, but when venturesomeness or decisiveness approaches impulsiveness (Kagan, Pearson, and Welch, 1966), when self confidence borders on dogmatism or complacency, and when self criticism becomes self derogation, the opposite effect may be anticipated Anxiety level, as pointed out earlier has a negative effect on problem solving, particularly in the case of novel and difficult tasks, because of its relationship to rigidity, constriction of the cognitive field, perseveration, disposition to improvise, premature closure, and intolerance for ambiguity

Personality variables undoubtedly interact with such situational factors as success and failure Success experience enhances self confidence, venturesomeness, and disposition to improvise, whereas failure experience has the opposite effects (Rhine, 1955) A mild degree of failure, however, may prove salutory by increasing drive, attentiveness, and willingness to consider other alternatives (George, 1964)

## The Trainability of Problem Solving Skills

The issue of whether, and to what extent, problem solving skills are trainable has a long and confused history both in psychology and education Much of the confusion stems from failure clearly to specify the different sources of variance in problem solving ability and to determine their relative susceptibility to training Equally important in this regard is the tendency to extrapolate findings from fragmentary short term laboratory studies to long term changes in problem solving capacity, both in academic and real life settings For the most part, also, investigators have tended to ignore the problem of the generality of the effects of training

Perhaps the most widespread approach to training in problem solving is to instruct the learner in various general principles that have emerged from theoretical analysis of the thinking process and from comparative observations of successful and unsuccessful problem solvers Such general hints include the following formulate and delimit the problem before trying to solve it, avoid the narrowing of attention to a single aspect of the problem, go beyond the obvious, be aware of and avoid the possibility of functional fixedness and negative transfer, abandon unpromising leads and explore other alternatives, question the reliability and representativeness of your data, make explicit the assumptions underlying any set of premises, distinguish clearly between data and inference, make use of the information derived from disconfirmed hypotheses and accept with caution conclusions that agree with your own opinions Some success has been reported for this approach (Bloom and Broder, 1950, Maier, 1930) It must be appreciated, however, that such instruction while having applicability to almost all problems, is so general in nature that its usefulness in any particular problem is rather limited The aspects of problem solving that are more specific to a given discipline undoubtedly influence problem solving outcomes more significantly than do these hints about problem solving in general

Short term training programs designed to develop or enhance specific kinds of thinking ability have not been generally successful (Ausubel and Schiff, 1954, Ervin 1960b, Smedslund, 1961, Wohwill and Lowe, 1962) However, long term and intensive training, using programmed instruction techniques, has led to the acquisition, retention, and transfer of rather complex problem solving skills in first grade children (R C Anderson, 1965) Similarly, training in using alternative solutions has been shown to enhance positive transfer in problem solving (Ackerman and Levin, 1958, Riopelle, 1953 Schroder, and Rotter 1952) In all of those studies, of course, the generality of the transfer effect was minimal More ambitious training programs striving for more generalized enhancement of thinking include J R Suchman s Inquiry Training Program, M L Abercrombie s group discussion approach, brainstorming techniques (Parnes and Meadow, 1959) and R S Crutchfield s (1966) provision of systematic, long term practice and feedback in exercises designed to enhance productive thinking None of these investigators, however, has been able to demonstrate any impressive degree of transfer to problem solving situations in other contexts, disciplines or subdisciplines. Their efforts, in other words, foundered on the improbable thesis that there is such a thing as a general heuristics of discovery Discredited theories in psychology, such as the doctrine of formal discipline, tend to die hard. They are periodically revived under other more palatable rubrics and slogans B O Smith s (1960) approach, based on training in the logic and heuristics of particular disciplines is more consonant with what is known about scientific method, the heuristics of problem solving, and the transferability of problem solving skills However, he has yet to adduce empirical support for his formulations

*The teaching of critical thinking in a generalized, global* sense is little more than an illusory goal and a recurrently fashionable slogan in education On both theoretical and practical grounds it can never amount to more than a critical *approach to the teaching of particular subject matter disciplines* Much of such teaching can be employed within the framework of an active form of reception learning supplemented by both guided discovery and more autonomous problem solving experience Precise definition of terms is stressed, explicit delineation of similarities and differences between related concepts is emphasized, a critical, questioning attitude is fostered and integrative reconciliation of ideas reformulated in idiosyncratic language is encouraged Pupils are taught to recognize and challenge assumptions and to distinguish between hypotheses, assertions, and facts, as well as between warranted and unwarranted inferences They are familiarized with the basic theoretical, epistemological, and methodological problems of each discipline and with its characteristic strategies of discovering knowledge Language is used precisely and students are sensitized to verbal magic, theoretical sophistry, and uncritical extrapolation and analogy In furthering all of these objectives much use can be made of skillful Socratic questioning

To summarize, the chief sources of variance in problem solving ability are (a) subject matter *knowledge* and familiarity with the distinctive logic of a discipline, (b) such *cognitive* determinants as problem sensitivity, originality, and intellectual curiosity, cognitive style, general knowledge about effective problem solving, mastery of special problem solving strategies in particular disciplines, and (c) such *personality* traits as drive, persistence, flexibility, and anxiety In the cases of such determinants as problem sensitivity, originality, cognitive style, and personality factors, most of the variance is probably a function of genic endowment and cumulative past experience, it stands to reason, therefore, that these aspects of problem solving ability are not very trainable Hence, the most promising approach to training in problem solving focuses on subject matter knowledge, on the logic and strategy of problem solving in particular disciplines, and on general principles of effective problem solving

## Creativity

Creativity is one of the vaguest, most ambiguous, and most confused terms in psychology and education today This is particularly unfortunate because teaching for creativity has become one of the latest and most flourishing fads and catchphrases on the current educational scene Partly because of the conceptual confusion surrounding this term, many otherwise hardheaded educators have adopted highly unrealistic educational objectives regarding the nurturance of creativity, and many otherwise well trained educational and school psychologists have deluded themselves into believing that they are able to identify pupils with unusual potentialities for creativity

Much of the semantic confusion regarding the term "creativity" stems from failure to distinguish between "creativity" as a trait inclusive of a wide and continuous range of individual differences, and the "creative person" as a unique individual possessing a rare and singular degree of this trait, that is a degree sufficient to set him off *qualitatively* from most other individuals in this regard The same difficulty also exists with respect to "intelligence, but gives rise to less confusion because the term is more familiar Everyone agrees that all degrees of intelligence exist, that even an imbecile exhibits some manifestations of intelligent behavior But when we refer to an "intelligent person, we mean only someone who is at the upper end of the distribution of IQ scores, someone who exceeds a hypothetical cut-off point separating intelligent individuals from the general run of mankind Thus, although creativity undoubtedly varies along a continuum, only the rare individual who makes a singularly original and significant contribution to art, science, literature, philosophy, government, and so forth, can be called a creative person The creative person is, by definition, a much rarer individual than the intelligent person Thousands of intelligent individuals exist for every one who is truly creative

It is important, therefore, to preserve the criterion of unique and singular originality in designating a person as creative All discovery activity is not qualitatively of one piece In the course of growing older, for example, every infant inevitably discovers that objects continue to exist even when they are out of sight, this discovery, however, hardly manifests the same *quality* of creativity as Einstein's formulation of the theory of relativity. Similarly, a sixth grade pupil may exhibit some degree of creativity in composing a song or writing a poem, but this does not mean that his accomplishments differ from Bach s and Shakespeare's merely in degree rather than in kind The fact that it is often difficult to measure originality, and that great discoveries may frequently go unrecognized for decades or centuries, does not detract in the least from the existence of qualitative differences in creative achievement A creative person must do more than simply produce something that is novel or original in terms of his *own* life history.

A truly creative individual, therefore, is rare not primarily because he lacks appropriate experience to develop his creative potentialities, but because he is, by definition, at such an extreme point in the distribution of creative potentialities that he is qualitatively discontinuous from persons exhibiting lesser degrees of creativity This is not to deny the important role of the environment in the development of creativity; many potential Mozarts, for example, have spent their lives as peasants and cobblers But even assuming an optimal environment, creative individuals would still be extremely rare The principle determinant of creative persons in other words, is genic within a specified range of environmental influences These latter influences function more as limiting rather than as directive factors A good environment is less of a formative influence in the actualization of creative potentialities than a guarantee that the necessary opportunities for their development are present

A second source of semantic confusion regarding the concept of creativity reflects the failure to distinguish between creativity as a highly particularized and substantive capacity (a rare and unique manifestation of talent in a particular field of endeavor), and as a general constellation of supportive intellectual abilities personality variables and problem solving traits Typical of the latter conception of creativity is Torrance s definition of creative thinking as the process of sensing gaps or disturbing, missing elements, forming ideas or hypotheses concerning them, testing these hypotheses, *and communicating the results, possibly modifying and retesting* the hypotheses (Torrance, Yamamoto, Schenetzki, Palamutlu, and Luther, 1960) These latter aspects of intellectual functioning presumably include such component traits or abilities as originality, redefinition, adaptive flexibility, spontaneous flexibility, word fluency, expressional fluency, associational fluency, and problem sensitivity (Guilford and Merrifield, 1960, Guilford, Wilson, Christensen and Lewis, 1951, Kettner, Guilford, and Christensen, 1959) Much stress also, is currently laid on divergent thinking as the distinctive attribute of creative thinking and such Guilford type tests as unusual uses, consequences, impossibilities, problem situations and improvements (Guilford, Wilson, Christensen, and Lewis, 1951) have been employed to measure this ability

However, without denying in any way the existence of general supportive abilities, it must be insisted that such probabilities do not constitute the essence of creativity It is true that they are probably more intrinsically related to creative achievement than is IQ Genuinely creative talent, nevertheless, is a particularized intellectual personality capacity related to the *substantive* content of a given field of human endeavor, rather than a set of general, content free intellectual and personality traits, and with increasing age it probably becomes increasingly particularized in its expression Creative achievement, in other words, reflects a rare capacity for developing insights sensitivities, and appreciations in a circumscribed content area of intellectual or artistic activity [2] This capacity is obviously not coextensive with any one general ability such as divergent thinking, although the possession of this latter ability, and of other supportive abilities as well, undoubtedly facilitates the actualization of particularized and sub-

[2] It may sometimes happen of course that a single individual possesses more than one creative talent

measures of creative aptitude, on the other hand, exhibit satisfactory generality over component elements, and can, therefore, be considered reflective of a stable cognitive trait that both plays a supportive role in creative performance and is independent of intelligence

Much more important than the relationship between intelligence and supportive measures of creativity is the relationship between intelligence and true substantive creativity The evidence invariably shows that creative individuals in art, literature and science are more intelligent than non creative individuals (Drevdahl and Cattell, 1958, Hitt and Stock, 1965), and that high IQ persons contribute much more than their share of notable and original discoveries in the various disciplines (Terman and Oden, 1959) This suggests, of course, that intelligence like other supportive cognitive traits, makes possible and implements the expression of substantive creativity (Price and Bell, 1965) In other words, a certain minimal degree of intelligence above the average is necessary for the actualization of creative potentialities But above this critical level the relationship between intelligence and true creativity is approximately zero (Drevdahl, 1956, MacKinnon, 1962, Terman and Oden, 1959) The noncreative high IQ individual who does very well on academic tasks and is vocationally successful, but who never generates an original idea, is a very familiar figure in our culture Contrariwise, many highly creative individuals do not sport spectacularly high IQ s

### *Creativity and Academic Achievement*

Research findings on the relationship between creativity and academic achievement tend to be contradictory Some investigators (Cline, Richards, and Needham, 1963, Getzels and Jackson, 1959, 1962, Torrance, 1960a, Yamamoto, 1964 a, b, and c) report that scores on Guilford and Torrance type creativity tests correlate just as highly with criteria of academic achievement as do intelligence test scores They find no difference in academic achievement between high creativity groups and high intelligence groups despite a mean difference of about 20 points in IQ between the two kinds of groups High creativity individuals are also significantly superior to low creativity individuals on all sub-tests of the Iowa Test of Educational Development when the effects of intelligence are controlled statistically (Yamamoto, 1961c) I Flescher (1963), however, obtained no significant relationship between creativity test scores and academic achievement scores, and M P Edwards and L E Tyler (1965) found that a high intelligence group of ninth graders was superior to a high creativity group on both achievement test scores and grade point average

Flescher's (1963) data provide a possible means of reconciling these contradictory findings Since his measures of creativity were unrelated to intelligence test scores, it could be argued that the positive correlations between creativity and achievement in the other studies reflected the signif icant relationship between creativity and intelligence measures in these latter studies However this cannot be a complete explanation because when the effects of intelligence are statistically controlled, high creatives are still superior in achievement to low creatives (Yamamoto 1964c) Another pos sibility, in view of the low intercorrelations among creativity tests, is that some of these tests may be positively related to achievement whereas others are not On purely *deductive* grounds it seems quite unlikely that creativity should be related to academic achievement, inasmuch as mastery of a given subject matter discipline does *not* in any way presuppose conspicuous ca pacity for making original or creative contributions to that discipline As a matter of fact, since creative students tend to be nonconforming and dis-ruptive of classroom routine, and hence often irritate their teachers (Getzels and Jackson, 1962) we can anticipate a negative relationship between cre ativity and school grades This is precisely what M P Edwards and L. E Tyler (1965) did find when comparing ninth grade pupils who were in the upper third of the distribution in both scholastic aptitude and creativity, with pupils who ranked high in scholastic aptitude alone

### *Personality Correlates of Creativity*

Considerable research has been conducted on the personality charac teristics of persons who have been rated by competent judges as creative in such areas as art architecture, literature and science In general, these traits are consistent with what one would expect of original and talented indi viduals who have achieved success and recognition in their chosen fields On the cognitive side, creative individuals tend to be original, perceptive, insightful, independent in judgment, open to new experience (especially from within), skeptical and verbally facile They are flexible, open minded, and tolerant of ambiguity, have wide ranging interests, prefer complexity, and are less interested in small details and in the practical and concrete than in theoretical ideas and symbolic transformations (Barron 1963, Drev dahl, 1956 Drevdahl and Cattell, 1958, MacKinnon, 1960, 1961, and 1962) In general they delight in paradoxes and in reconciling opposites From a motivational standpoint they are ambitious, achievement-oriented, domi nant, and have a sense of destiny about themselves They tend to be emo-tionally mature, venturesome self sufficient, and emotionally and aesthet ically sensitive Their self image abounds in such traits as inventiveness, determination, industry, independence, individualism, and enthusiasm On the whole, they exhibit higher ego strength and self acceptance, more intro-spectiveness and greater femininity than noncreative individuals In their relations with others they are unconventional, rebellious, disorderly, self centered, exhibitionistic, and prone to retreat to the role of observer They tend to make deviant scores on the Minnesota Multiphasic Personality Inventory, but this is undoubtedly more reflective of complexity of personality, candor, lack of defensiveness, and openness to experience than of genuine personality distortion (Barron, 1963, Drevdahl, 1956, Drevdahl and Cattell, 1958, Hammer, 1961, MacKinnon, 1960, 1961, 1962)

Of somewhat less psychological significance are the personality characteristics associated with the supportive cognitive criteria of creativity M A Wallach and N Kogan (1965) found that their high creatives tended to be broad rather than narrow categorizers, to be tolerant of an unconventional type of hypothesizing about the world, and to be responsive to affective aspects of the environment Their high-creative high intelligence group were high in self confidence and self-esteem and low in defensiveness, enjoyed a high sociometric status actively sought the companionship of others, and exhibited a high attention span and ability to concentrate, but at the same tended to display more than their fair share of attention seeking and disruptive behavior On the other hand high creatives who were low in intelligence exhibited the opposite set of characteristics except for attention seeking, disruptive behavior in the classroom Anxiety level was middling for the high creative groups when it was either very high or very low, it appeared to depress creativity This suggests either that a moderate degree of anxiety is necessary to generate creative behavior or that the expression of creativity is productive of moderate anxiety

### *Identification of Creative Potentialities*

It follows from our substantive conception of creativity that potentiality for creativity can be measured only in terms of capacity for sustained and highly original achievement in an important area of human endeavor Although knowledgeable experts can reliably and validly identify creativity after it has matured and eventuated in a substantial body of work or performance, the identification of creative potential prior to actualization is a much more difficult matter Satisfactory methods are not yet available Self-estimates are invariably inflated and have little validity (Feldhusen, Denny, and Condon, 1965, Richards, Cline, and Needham, 1964) Teacher estimates are not much more satisfactory because they are based on generalized impressions, they exhibit low inter rater reliability (Piers, Daniels, and Quackenbush, 1960) The only feasible approach seems to lie in expert judgments of actual work products taking inexperience, immaturity, and varying rates of development into consideration (Eisner, 1965)

Some shortcomings of Guilford and Torrance type tests, emphasizing divergent thinking as measures of creative potential have already been considered In the first place, they do not exhibit an independent common quality, generally correlating as highly with intelligence as they do among themselves Second, scores on measures of divergent thinking are indeterminably contaminated by such factors as verbal fluency and glibness uninhibited self expression, impulsivity and deficient self critical ability Third, these instruments have not been validated against substantive creativity in later life Lastly, on *deductive* grounds alone, they cannot possibly have high predictive validity inasmuch as they do not measure substantive creativity but rather various supportive cognitive traits

M A Wallach and N Kogan (1965) devised a measure of creative potential based upon the total number and uniqueness of relevant associations under conditions that maximize task—as opposed to ego orientation This measure is more homogeneous than the Guilford type tests is more independent of intelligence, exhibits higher generality of function, and is less influenced by contaminating factors However, the same limitations regarding validity still apply with equal force These investigators attribute intra individual incongruity between creativity and intelligence test scores to lack of flexibility in responding to evaluative and nonevaluative situations respectively It seems more parsimonious, however, to attribute such discrepancy to the independence of the abilities measured by the two kinds of instruments

In recent years, much interest has been expressed in the use of curiosity as an index of creative potentiality At the very most however, curiosity can be regarded as a supportive motivational variable that is possibly related to creative achievement, evidence regarding this relationship is not yet available Measurement is also a difficult problem Teacher, peer, and self ratings (Maw and Maw, 1961 and 1962) are of questionable reliability and validity Generality of function is another serious problem Even if a general factor of curiosity could be identified, it would probably have little psychological significance, since it is the level of curiosity in *particular* substantive areas that affects the productivity or creativity of an individual s work

## *Fostering Creativity in the School*

Much militant sentimentality underlies the currently popular educational objective of making *every* child a creative thinker and of helping him discover discontinuously new ideas and ways of looking at things This objective, is in part a wish fulfilling extension of our present day preoccupation with actualizing the creative potentialities of gifted children But it also harks back to the official environmentalistic bias of progressive education and to the naive conception of human plasticity which holds that, even if a child has no creative potentialities, inspired teaching can create them anyway Unique creativity, it is alleged is not the exclusive property of the rare genius among us but a tender bud that resides in some measure within every child, requiring only the gentle, catalytic influence of sensitive, imag mative teaching to coax it into glorious bloom This notion has received some indirect support from recent developments in the mental measurement movement If, for example we accept the premise that the structure of intellect can be analyzed into a multiplicity of separately identifiable cognitive abilities or factors—as many as 120 according to J P Guilford (1959) —the conclusion seems inescapable that simply on the basis of probability, almost every child is destined to become a genius or a near genius with respect to at least one factor, and even if a particular child were to receive an unlucky shake of the genic dice, a benevolent educational environment would certainly make up for the difference

The currently popular objective of teaching for creativity"—to make every child an original and creative thinker—is, therefore, based on one or more of four untenable propositions The first proposition assumes that every child, by definition has potentialities for unique creativity providing that they are not stifled by the educational system This, of course, is sheer sentimentality since such potentialities are extremely rare The second proposition is reflective of the naive view of human nature which asserts that even if a child has no creative potentialities, inspired and sensitive teaching can compensate for missing genes The third proposition, ignoring the distinction between creativity and the creative individual, advances a watered-down, democratic definition of creativity that employs an *intraindividual* criterion of originality and assumes that all creativity is qualitatively of one piece By the very same token, however, if this criterion of creativity is used, the educational objective of making every pupil a creative individual becomes so watered down that it becomes virtually meaningless The final proposition simply rests on the previously discussed assertion that the supportive creative abilities are coextensive with substantive creativity.

Research on training for originality has yielded very limited success Subjects can be trained to respond with more unusual associations, to generate more novel ideas, or to suggest more unusual uses (Anderson and Anderson, 1963, Cartledge and Krauser, 1963, Crutchfield and Covington, 1963, Freedman, 1965, Maltzman, 1960, Mednick, Mednick, and Jung, 1964), and, in some instances, transfer to related kinds of problem solving does take place Such transfer, however, occurs in a very restricted range of contexts and sometimes does not occur at all (Anderson and Anderson, 1963, Maltzman, Belloni, and Fishbein, 1964) Moreover, this kind of training implicates various supportive traits of creativity rather than substantive creativity itself The same limitations apply to more general types of creativity training that depend on classroom milieu (G I Brown, 1964) or on the communication of a set of principles about how to be creative (Torrance, 1961)

Some research data are available on the school and family backgrounds of students who make high scores on the supportive aspects of creativity.

The latter individuals 'tend to diverge from stereotyped meanings, to move away from the model provided by teachers to seek out careers that do not conform to what is expected of them (Getzels and Jackson, 1962), and to challenge the opinions and assumptions of teachers (MacKinnon, 1962) The parents of these students tend to be expressive and nondominating and to work in occupations permitting much autonomy (Weisberg and Springer, 1961) They focus on such qualities as the child s openness to experience, his values, his interests, and enthusiasm for life, rather than on academic success, cleanliness, good manners, and studiousness (Getzels and Jackson, 1962)

How reasonable is the goal of teaching for creativity, that is, in the sense of singularly original achievement? A decent respect for the realities of the human condition would seem to indicate that the training possibilities with respect to this kind of creativity are severely limited The school can obviously help in the realization of existing creative potentialities by providing opportunities for spontaneity, initiative and individualized expression, by making room in the curriculum for tasks that are sufficiently challenging for pupils with creative gifts and by rewarding creative achievement But it cannot actualize potentialities for unique creativity if these potentialities do not exist in the first place Hence it is totally unrealistic, in our opinion, to suppose that even the most ingenious kinds of teaching techniques that we could devise could stimulate singular creative accomplishment in children of average endowment Since unique creative potentialities are, by definition, sparsely distributed in the population, instances of singular creativity can be anticipated no more frequently among the clientele of our schools than among any other population of human beings Actually, such creativity is a rare gift The school can help only in actualizing its expression in those rare individuals who already possess the necessary potentialities It can of course, also help in the realization of average and less unique levels of creative potential

> Research tells us that children and adults develop along the lines that they find rewarding If schools are to develop the creative thinking abilities they must find ways of rewarding this kind of thinking or achievement In the main current school curricula at all levels of education are designed to develop and make use of the kinds of thinking abilities reflected in traditional tests of intelligence No one is suggesting that the development of these abilities be eliminated It is only suggested that parallel treatment be given the creative thinking abilities as well as other abilities not adequately represented in our present tests of intelligence (Torrance, 1960b pp 68 69)

How important, then, one might legitimately ask, is it to identify pupils with true creative potentialities Persons belonging to the genius will out school of thought would argue that these potentialities will be actualized irrespective of what the school does or fails to do The realization of creative potentialities, however, like the expression of any genically determined tendencies, is seldom an all-or-none proposition It is true that in certain instances genic factors are so prepotent, or all of the relevant personality, motivational, family, peer, and cultural variables are so overwhelmingly favorable, that a successful outcome is almost inevitable But in many other instances the influence of these variables is more equivocal, and a successful outcome hinges on the guidance, stimulation, and encouragement that is forthcoming from such agencies as the school

# EVALUATION AND MEASUREMENT

*Chapter 17*

# PRINCIPLES OF MEASUREMENT AND EVALUATION

*MEASUREMENT AND EVALUATION are integral parts of class room learning and hence of educational psychology as well* If we are really serious about education, we must have precise ways both of measuring learning outcomes in individual students and of ascertaining whether they are consonant with our educational objectives These measures, moreover, must do more than merely *inform us whether students are actually being* educated Equally important, they must provide data that make it possible for us to monitor and thus insure quality control over the educational enterprise Thus, at any given point in time, they must enable us to know how effective our educational program is, and if we hope to improve learning outcomes by introducing new teaching methods instructional materials, and ways of organizing subject matter content and curriculum sequences, measurement and evaluation necessarily enter the picture again

*Scientific research in education, as in any empirical and experimental* discipline, is completely unthinkable in the absence of reliable and valid measuring instruments and the data that they provide It is clear, therefore, that if education is to prosper, both teachers and students must learn to welcome regular and systematic testing rather than to regard it as a threat, an intrusion or a distraction from more important matters

Evaluation is important at the beginning during and at the conclusion of any instructional sequence First, one must decide what learning *outcomes one desires to induce and then structure the instructional process* accordingly Second it is necessary to determine the degree of progress toward the goal during the course of learning—both as feedback and motivation for the student and as a means of monitoring the efficacy of instruction Finally it is important to evaluate ultimate learning outcomes in relation to objectives both from the standpoint of student achievement and from the standpoint of teaching methods and materials With this type of feedback information we are then in a position either to modify the instruc tional program, or to redefine our goals if we are convinced that they are unrealistic. Such evaluation is typically longitudinal or extended in nature since the effects of a curriculum on the educational product are not ascer tainable immediately These kinds of evaluative studies, therefore, involve the systematic collection of large quantities of data over many consecutive years

In this chapter we can briefly consider only such general issues as the purposes and limitations of measurement and evaluation, the requirements that an effective measuring instrument must meet, the nature of standard ized tests, the interpretation of test scores, and various informal methods of measurement and evaluation Detailed discussion of these issues as well as particular aptitude and achievement tests both individual and group, more properly belongs in a separate course on tests and measurements

## The Purposes of Measurement and Evaluation

In general, the function of evaluation is to determine the extent to which various significant educational objectives are actually being attained To evaluate is to make a judgment of worth or merit, to appraise educa tional outcomes in terms of whether they fulfill a particular set of educa tional goals Apart from ascertaining whether such goals are being realized, any assessment of the outcomes of schooling is meaningless No educational outcome is good or bad in and of itself Its worth can be considered only in terms of how far it accomplishes the ends we are striving to achieve through education All too frequently however, educational objectives are not clearly or explicitly formulated in advance Thus it is small wonder that neither the instructional program nor the learning outcomes that are being evaluated bear much relation to the goals that are professed

It follows therefore, that the educational enterprise cannot be con- ducted efficiently unless it is directed toward the achievement of certain designated goals Only after formulating clearly what it is we hope to ac complish through our educational efforts are we in a position rationally to determine the content and methods of instruction and to evaluate the outcomes of such instruction It is probably true that educational objectives can be meaningfully expressed only in such behavioral terms as understand ings appreciations capabilities, attitudes and so forth But if these behav- ioral goals are to have any real meaning and impact on education, we must go beyond a formal taxonomy of cognitive and affective objectives that mean different things to different persons and try to reach consensus on the processes underlying the behaviors in question The next step is to devise an appropriate instructional program that can realize the objectives we designate as important, and to determine what kinds of evidence of attainment of a given objective are both theoretically defensible and subject to reliable and valid measurement In addition to standardized testing we have to consider such methods of evaluation as essay and oral examinations, observation, ratings, and the appraisal of work products

It is often held that the determination of educational objectives is the exclusive prerogative of the educational philosopher However, it would seem that as a social scientist concerned with how knowledge is acquired, with the nature and limits of human capacities, and with developmental changes in cognitive processes, the educational psychologist is in as strategic a position (and hence as entitled) as anyone to express a value judgment regarding the objectives of education In the first place he knows what is realistically possible and how best to implement it There is no rigid dichotomy between knowing what is possible and knowing what is desirable In fact, since it would be patently foolish to aim for what is not possible, those who are in the best position to know what is possible should ideally have much to say about determining what is most desirable Second, better than any other professional concerned with the educational enterprise, the educational psychologist is able to translate highly general objectives into more explicit intellectual goals

### *To Facilitate Student Learning*

The primary purpose of evaluation is to monitor the student's learning—to constitute an objective check on both his progress and ultimate achievement so that if either is unsatisfactory, suitable remedial measures may be instituted Thus, a really adequate evaluation program not only assesses the extent to which student achievement realizes educational objectives, but also attempts to account for unsatisfactory achievement—irrespective of whether this inheres in unsuitable instructional methods or materials in incompetent teaching, in inadequate student morale or motivation, or in insufficient readiness and aptitude As a product, student learning is no different from any other significant human endeavor that society takes seriously considerations of efficiency and quality control presuppose systematic and rigorous assessment

Resistance to evaluation largely reflects a long history of nonacceptance of this latter proposition in certain educational circles In fact, two of the principal assumptions underlying the child centered approach to education (progressive education) are that (a) the *really* important objectives of education are intangible and untestable, and (b) the application of objective standards of assessment to pupils learning is inherently repugnant to and incompatible with the ethos of a humanistic education These arguments have been further bolstered by the assertion that genuine measurement is possible only in the physical sciences (B O Smith 1938) and by calling attention to limitations and abuses of measurement in education (see below) In our view this position stems largely from a sentimental and semi mystical approach both to children and to the educational process The fact that educational objectives have been vaguely stated in the past or that measure ment of educational outcomes has hitherto focused on relatively trivial aspects of school learning does not mean that this must necessarily be the case Nor does the fact that behavioral measurement cannot possibly yield data that are as precise reliable and valid as in the physical sciences pre clude the construction of adequately reliable and valid measuring instru ments in psychology and education or their usefulness in evaluating student performance and instructional programs Finally the fact that any aspect of the educational program necessarily has its limitations and is subject to abuse does not mean that it should be discarded as valueless It merely argues for intelligent and sophisticated use of measuring instruments based on awareness of their limitations and of the possibilities of abuse

Apart from its monitoring function evaluation facilitates student learn ing in many ways In the first place it encourages teachers to formulate and clarify their objectives and to communicate their expectations to stu dents Frequently of course examination content reflects no explicit set of teacher goals or is even in direct conflict with professed goals Neverthe less nothing indicates more unambiguously what knowledge and skills teachers regard as important than the kinds of examination questions they set It has been shown that students distribute their study time and appor tion their learning effort in direct proportion to the predicted likelihood of various topics and kinds of information being represented on the exam ination (Keislar 1961) These predictions are based on the degree of explicit or implicit emphasis placed on a given topic on examination hints on student folklore on the teacher s reputation and on knowledge of or ex perience with previous examination questions They include not only ex pectations with respect to topical coverage but also expectations regarding the kinds of mastery to be demonstrated—factual recall evidence of com prehension critical analysis or interpretation application problem solving ability to marshal evidence and synthesize knowledge and so forth It is evident therefore that if teachers wish to influence learning outcomes in particular ways by the kinds of evaluative devices they use they must for mulate their objectives clearly communicate these objectives explicitly to students (instead of trying to outwit them) and construct reliable and valid measuring instruments that test the degree to which these objectives are realized Educational objectives no matter how praiseworthy simply go by the board if they do not receive representation in the scheme of evalu ation But if communicated adequately and anticipated on examinations, they can direct the kind of learning that takes place

Second, the examination itself is a significant learning experience It forces students to review, consolidate, clarify, and integrate subject matter in advance of being tested and also performs a comparable review function during the course of the test Feedback from an examination confirms, clarifies, and corrects ideas, and differentially identifies areas requiring further thought and study Merely identifying the correct answers on a multiple choice test significantly increases retest scores a week later (Plowman and Stroud, 1942)[1] This corrective function of feedback is extremely important since students often feel 'certain' about incorrect answers (Kooker and Williams, 1959) The motivational effects of feedback have been discussed in another context

Third, as pointed out earlier, examinations play a significant motivating role in school learning Within limits, desire for academic success, fear of failure, and avoidance of guilt and anxiety are legitimate motives in an academic setting It would be wholly unrealistic to expect students to study regularly, systematically, and conscientiously in the absence of periodic examinations Frequent quizzing markedly facilitates classroom learning (Fitch, and others, 1951, Kirkpatrick, 1939, Ross and Henry, 1939)

Lastly, from the experience of being subjected to external appraisal, students learn how independently to evaluate their own learning outcomes Such self evaluation enhances school achievement (Duel, 1958) and is particularly important once students complete their formal schooling It is also part of the long range objective of increasing students' capacity for appraising their abilities and achievement validly and realistically

### *To Facilitate Teaching*

Measurement and evaluation provide teachers with essential feedback regarding the effectiveness of their instructional efforts They indicate to the teacher how effectively he presents and organizes material, how clearly he explains ideas, how well he communicates with individuals who are less sophisticated than he is, and how efficacious particular instructional techniques or materials are Feedback from examinations identifies areas requiring further explication, clarification, and review, and is invaluable in the diagnosis of learning difficulties, both individual and group The objective examination is also a necessary corrective against the subjectivity and impressionism of more informal methods of evaluation which are frequently contaminated by favoritism and reward for docility and neatness (R S Carter, 1952)

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[1] See also the long term effects of feedback Chapter 8

### *To Appraise Curricula and to Make Curriculum Judgments*

As indicated previously, measurement and evaluation are essential for monitoring a curriculum—for assessing the merit of a particular sequence and organization of courses embracing designated subject matter content, instructional materials, and methods of teaching. The data they furnish are also helpful in making such administrative decisions as the grade placement of subject matter and the optimal sequencing of courses. It goes without saying that research both on curriculum and on the learning process itself would be impossible without reliable and valid measures of learning outcomes.

### *To Assist in Guidance, Counseling, and the Individualization of Instruction*

Systematic measurement and evaluation of aptitude, achievement, motivation, personality, attitudes, and interests is necessary for individualizing instruction and for purposes of individual guidance and counseling. We must know the current aptitude levels of pupils and the current state of their subject-matter knowledge before we can "prepare curriculum materials appropriate to ability levels [and] adapt teaching methods to the learners and the content to be learned" (Adkins, 1958). In the absence of such information, intelligent decisions also cannot be made about grade placement, grouping, the pacing of study, promotion, choice of courses, academic and vocational goals, and remedial work. These data, finally, are essential for reporting pupil progress to parents and for explaining to them the basis on which particular decisions are made.

## Limitations and Abuses of Evaluation and Measurement

In the long history of the measurement movement in education, many objections have been raised both to the goals of educational measurement and to the effects produced by particular techniques of measuring learning outcomes. Some of these objections do, in fact, identify palpable limitations, abuses, and shortcomings. Others are based on sentimental and semimystical conceptions of the educative process. It is important to scrutinize these objections carefully and to distinguish between those which are based on *inherent* limitations and shortcomings of educational measurement and those which are based either on correctable abuses or on attainable capabilities that are as yet unrealized.

First, it is argued that educational tests tend to evaluate the more tangible, trivial, and easily measurable as opposed to such more significant outcomes of education as genuine understanding, originality, problem solving ability, ability to think independently ability to retrieve information, ability to synthesize knowledge, and so forth This criticism however, is warranted only in relation to the early standardized tests measuring rote retention of factual information It must be remembered that objective tests are now available which measure both comprehension of general principles and ability to interpret and apply knowledge Furthermore many other kinds of measuring devices can be used to evaluate some of the more elusive outcomes of education These include observation self reports, peer judgments, essay tests, oral examinations, work samples, practical examinations, research papers, and so forth It is true that valid measures of such important traits and abilities as cognitive style, creativity, problem solving strategy, flexibility, and problem sensitivity have yet to be devised But there is no reason to believe that currently encountered difficulties in devising these measures will not eventually be overcome

Second, it is frequently alleged that educational measures fail to test the attainment of objectives that are *idiosyncratic* to a particular school system, curriculum, institution or teacher Again this objection mistakenly regards the use of national standardized tests as coextensive with educational measurement There is no incompatibility between using tests standardized on a broad, representative sample and tests prepared especially for a particular school system, school, curriculum, or classroom Where advisable both kinds of measures can and should be used

Third, test scores and school marks often become ends in themselves, displacing in importance and presumed validity the knowledge, competencies, and scholastic achievement they are intended to sample and represent When this happens, cognitive drive atrophies, pupils lose interest in subject matter as soon as their grades are recorded, and society places greater weight on a test score or on a diploma from a prestigious institution than on intrinsically more valid long term evidence of scholarship and fitness to practice a profession This perversion of the nature and function of measurement is in a sense inevitable in a complex society where the meaning and purpose of symbols tend to get lost in time The same persons who pay more attention to the university from which a criminal lawyer graduates and to his law school grades than to his success over the years in gaining acquittals for his clients, would not dream of placing greater reliance on a spot check of ten apples in a barrel than on the evidence available from an individual inspection of every apple Nevertheless the solution to this dilemma is not to abolish measures of aptitude and achievement or to cease evaluating educational institutions, but to increase public sophistication about the nature of measurement and to combat test score and degree worship wherever and whenever they appear

The tendency to regard test scores as ends in themselves and as more important than the knowledge they represent is much more a *reflection* of undesirable social attitudes about the real value of scholarship than a cause of such attitudes or an inevitable product of measurement and evaluation Thus overemphasis on the competitive aspects of testing and on the use of test scores for creating a meritocracy or a pseudo-scientific rank ordering of persons tells us much more about the kind of society that sanctions such practices than about the potential abuses of measurement Similarly if teachers are guided in their choice of subject matter content solely by the desire to prepare students for standardized tests and even go to the extent of coaching them on type questions it is more rational to blame the existing values of parents educators and school boards than to blame the tests themselves Almost every aspect of culture—government mass media industry commerce recreation sex drugs religion—is just as subject to abuse and perversion as are measurement and evaluation It makes more sense in our opinion to prevent such abuses by increasing the level of public enlightenment about the relevant issues involved in intelligent use than by abolishing or outlawing the practice in question

Fourth advocates of child-centered teaching and client-oriented counseling insist that genuine learning independent thinking and creativity are possible only in a nonevaluative classroom atmosphere They assert furthermore that evaluation induces tension anxiety excessive competitiveness and overemphasis on extrinsic motivation In our opinion this position greatly overstates the case It is true that unintelligent and authoritarian use of evaluative techniques may encourage uncritical acceptance of ideas suppress originality and generate undesirable levels of anxiety competitiveness and interpersonal tension Nevertheless a reasonable degree of evaluation is still absolutely essential not only for monitoring and motivating learning but also for setting necessary and desirable standards of critical and original thinking In a completely nonevaluative setting creative effort is dissipated in amorphous undirected and undisciplined output. Freedom from anxiety is also an unrealistic goal since no significance or creative achievement is possible without some degree of anxiety the very act of aspiring to master a body of knowledge or to create something original raises the possibility of failure and depression of self-esteem and hence is anxiety producing by definition

As already pointed out moderate emphasis on competitiveness in school facilitates achievement and self actualization and prepares students realistically for the world of work in Western culture Similarly extrinsic and aversive motivation within reason are necessary for sustained academic effort. School marks provide students with tangible evidence of success in mastering the curriculum are an important current source of status and self-esteem during childhood and adolescence and indicate that progress is being made toward the ultimate achievement of vocational goals and adult status

Fifth, evaluation has frequently been misused by teachers as a means of rewarding students for conformity and docility and of punishing them for nonconformity and independence of thought. In many schools and universities it is still employed as a weapon for controlling and intimidating students, for frightening and impressing them (as well as colleagues), and for making them feel inadequate subservient and deferential It is these very same teachers who conceive of examinations as a contest in which students are to be outwitted and trapped into error Needless to say however, this crude abuse of evaluation hardly constitutes a valid argument for non evaluative teaching

Sixth, it can be claimed with some justification that good scores on achievement tests are beyond the reach of low ability students In a very real sense then, the imposition of absolute standards of final achievement, or the use of grades based on relative standing in the class depresses their self-esteem and discourages them from putting forth their best efforts Such detrimental effects, however, can be largely mitigated by concomitant evaluation in terms of their ability level or in terms of progress from initial levels of performance These two different bases of evaluation are by no means mutually exclusive We need to know how well students are progressing both in terms of their own potentialities *and* in terms of group norms Furthermore, the negative impact of informing students that they are inferior to their peers in ability and achievement has undoubtedly been exaggerated. Realistic awareness of our relative intellectual status among our peers is a fact of life to which all of us must eventually adjust—and the sooner the better for everyone concerned There is no profit either in sugar-coating the truth or in self delusion

Finally, measurement and evaluation often fail to facilitate learning or teaching because they provide no meaningful feedback. This is particularly true when only final examinations are given and when only composite scores are reported to students without comment, explanation specification of component strengths and weaknesses or opportunity for identifying and correcting errors Such examinations encourage cramming provide an unrepresentative picture of student achievement, and abet "book slamming" as soon as the grades are in Any defensible program of evaluation therefore relies on periodic and frequent testing—before, during and at the end of instruction, uses several kinds of measures reports scores in differential rather than composite terms and stresses the feedback and diagnostic function of tests

## Requirements of an Effective Test

Any effective test irrespective of whether it is objective and standardized, on the one hand, or informal and "teacher made," on the other, must be valid reliable representative and feasible and should also discriminate adequately between individuals or groups of individuals tested

### *Validity*

The validity of a test refers to the extent to which it measures what it purports to measure The question of validity is always relative to the stated objectives of a test A test that is valid for one purpose (for instance to screen out gross personality deviates) is not necessarily valid for another (for example to make precise assessments of personality status to make a specific diagnosis of behavior disorder to make predictions of individual outcome)

The problem of validity arises in the first place because psychological and educational measures tend to be indirect and inferential rather than based on direct behavioral samples of the trait or ability in question An achievement test for example *merely assumes* that ability to answer correctly a particular set of subject matter items is really reflective of degree of mastery of a designated discipline or subdiscipline unfortunately there is no more direct way of measuring knowledge If on the other hand we endeavor to measure the trait of academic honesty by assessing behavior in controlled situations in which cheating on examinations can be detected unbeknown to and unsuspected by the subjects (Canning 1956 Hartshorne and May 1928) the question of test validity is irrelevant the only relevant question in these circumstances is that of reliability—will equivalent degrees of academic honesty be exhibited in a later time sample of the same situation in different but comparable samples of the same situation in related but different situations?

The more indirectly and inferentially a test score is related to the trait or ability it purports to measure the more important the issue of validity becomes Thus although an achievement test score is admittedly not coextensive with degree of mastery of a discipline it involves much less indirectness and inference for example than does an intelligence test score In the latter situation the trait itself is much more of a hypothetical and debatable construct the tests used to measure it are much less homogeneous and much less self-evidently related to the trait and there is a much greater presumption of the predictive value of the test score (of the constancy of the trait over age)

Several different types of validity have been delineated. A good test is characterized by at least one and hopefully by more than one of these types *Content* validity is a form of face validity that is invoked for many psychological and educational tests An achievement test for example may be claimed as valid on the face of things if it contains an adequate and representative sample of items—both in terms of the particular subject matter knowledge it purports to measure and the kinds of competencies or under standings that purportedly reflect such knowledge

*Concurrent* validity is present when test scores correlate reasonably well with some contemporaneous criterion of behavior preferably ratings based on direct observation Typically the question of current validity arises when some short cut method of assessment is devised to replace a more exhaustive and time consuming measure The difficulty in these instances is one of finding an appropriate criterion that is relevant reliable and valid itself School grades for example are a commonly used criterion for determining the validity of academic aptitude and achievement tests despite the fact that they are usually less reliable and less valid than the tests themselves and are also influenced by such extraneous factors as the motivation deportment docility and conformity of pupils and the personal and social class biases of teachers An added difficulty is the lack of comparability between the grades awarded by different schools and teachers This is shown by the spectacular increase in the correlation between high school and college grades when the former set of grades is rendered comparable from one school to another (Bloom 1964) Before any evidence of concurrent validity is applicable it is also necessary to demonstrate that one s population is comparable in all relevant respects to the sample on which the instrument was validated

When the criterion behavior to which test scores are related is some future measure of performance we deal with *predictive* validity If scho lastic aptitude scores for example correlate reasonably well with later school grades or academic achievement scores the aptitude test may be said to exhibit predictive validity The problem of finding a suitable criterion still remains A test measuring aptitude for medicine may yield scores that correlate satisfactorily with grades earned in medical school but to what extent are these scores related to success in the practice of medicine? Not only is it very difficult to measure professional success in medicine but there are also many different criteria of success varying for the most part with the individual s particular career choice (general practice specialty practice research teaching writing public health hospital administration)

A final type of validity that is often invoked when the other three evidences of validity cannot be demonstrated—either because the universe of content cannot be adequately specified or because of the absence of a suitable criterion—is known as *construct* validity This is based on logically defensible inferences from experimental or other evidence In the case of an achievement test the failure of a totally naive student population to obtain better than chance scores would provide one form of such evidence Other kinds of relevant evidence would include improvement in mean test scores from one grade level to another in such hierarchically ordered competencies as reading and mathematics and a strong positive relationship between aptitude and achievement at each grade level

VALIDITY IN ACHIEVEMENT TESTING From the standpoint of meaningful verbal learning, a truly valid test of subject matter achievement measures whether mastery of a designated body of knowledge is sufficiently stable, clear, and well-organized to reflect the structure of ideas in a given or sub discipline, to make long term retention possible, and to serve as a foundation for further learning in the same discipline Modern achievement tests, therefore, emphasize understanding of the more significant ideas within each discipline, and of the relationships among them, rather than rote mastery of discrete facts Nevertheless, despite this laudable emphasis on genuine comprehension of a structure of ideas, these tests fail adequately to measure the functional retention and organizational strength of knowledge because they are *immediate* tests of understanding and application Every teacher knows that any reasonably bright student can do enough cramming before an announced quarterly or final test to make a passing score, even though the same test questions would elicit only a blank stare several days later

Thus, conventional retention tests, covering previously studied material and administered at the end of a given course of instruction, are not truly reflective of the later availability of this material for new learning and problem solving purposes Because a short retention interval cannot adequately test the organizational strength and viability of newly acquired knowledge, and because of the contaminating influence of rote memory over short time intervals, such conventional measures of retention are often misleading They fail to distinguish adequately between the student who merely understands and retains material well enough at the moment of testing to answer rote and meaningful questions correctly, and the student whose understanding and retention are sufficiently stable on a long term basis to serve as a springboard for learning new, sequentially related material Both individuals may frequently make identical scores on immediate tests of retention Problem solving or application items provide a partial solution to this difficulty since they are less influenced by rote memory and also directly test ability to use and apply retained knowledge But since successful problem solving also depends on many *other* traits (venturesomeness, flexibility, perseverence, problem sensitivity) that are unrelated to the functional availability of knowledge, success or failure on such items is as much a reflection of the influence of these latter traits as of the availability of usable knowledge

Three other solutions to this problem of achievement test validity are available, none of which is mutually preclusive of the others or of the use of problem solving items First, the programmed instruction approach, which implies testing, feedback, and consolidation after *each* unit (topic, chapter) of subject matter material, provides adequate safeguards for the true stability and clarity of knowledge and insures against the dangers of cramming and rote learning If students are given such tests weekly, quarterly and final examinations serve more of a review function and become truly valid measures of subject matter mastery Second, comprehensive tests of achievement that are given six months to several years after the completion of a course also measure the functional retention of genuine knowledge as well as discourage the ' book slamming phenomenon Such delayed tests, however, obviously become measures of cramming ability unless they are preceded by weekly, quarterly, and final examinations

Finally, perhaps the most valid way of testing the organizational strength and viability of knowledge is not to test retention in itself, or to use problem solving items, but to measure retention in the context of sequential learning—in situations where ability to learn new material presupposes the availability of the old The ' transfer retention test (Ausubel and Fitzgerald, 1962) constitutes a new approach to the problem of measuring functional retention It attempts to do this by measuring the extent to which retained knowledge of subject matter is sufficiently stable and well-organized to be available as a foundation for learning new, sequentially dependent material that could not be efficiently learned in the absence of such availability At the same time, of course, it also provides a measure of knowledge available for problem solving because if retained knowledge is available for new sequential learning, it is reasonable to assume that it is also available for problem solving

The transfer retention test may be administered in addition to or independently of the conventional retention test When used for routine course examinations, the test procedure requires that students study an unfamiliar new learning passage that is sequentially related to and presupposes knowledge of the previously studied material on which they are being examined. Their scores on a test of this *new* material are ' transfer retention scores ' and measure the functional availability of the previously learned material for new learning

Only valid tests of achievement can be used to evaluate the worth of a new curriculum or course of study Thus, for the reasons given above, the ability of students to make satisfactory scores on *immediate* tests of understanding and application does not constitute proof that the material is adequately learnable, lucid, or properly programmed It is not surprising, therefore, that when the learnability of curriculum material is assessed by conventional tests of achievement, these latter tests often give spurious and misleading impressions of genuine learnability This is apparently the case when the yellow and blue BSCS versions are evaluated by means of the conventional achievement tests

Achievement test data show that the three BSCS versions are approximately as ' learnable ' as conventional textbooks It was demonstrated, for example, that students using the BSCS texts score somewhat higher than students using conventional texts on a final Comprehensive BSCS Test and somewhat lower on a final Cooperative Biology Test (Wallace, 1963) In the first place, it is questionable how well such final tests *really* measure the learnability of subject matter content Most adequately motivated students can learn,' for examination purposes, large quantities of overly sophisticated and poorly presented materials that they do not really understand, unfortunately, however in such circumstances little evidence of retention is present even a few days later Second one of the main objectives of any new, elaborately prepared curriculum program is presumably to exceed by far, rather than merely to approximate the level of academic achievement attained in conventionally taught courses

Achievement tests also tend to lose validity if they contain items that presuppose knowledge of materials that are not ordinarily included in the scope of the discipline or subdiscipline which they are designed to measure Many teachers for example, believe that they can discriminate more adequately between bright and average students if they use such questions Actually the reverse is true because these items either cannot be answered correctly by any students or else measure knowledge of some *other* field of study A good examination should emulate a good detective story the solution of problems should not depend on information that is unavailable to students or that they are not expected to learn

The validity of an achievement test depends in part on how well it tests the actual competencies that are demanded of an individual in those real life performances for which he is being trained or educated This is the issue of concurrent or predictive validity For example a multiple-choice examination on rules of the road may exhibit good content validity, but obviously has less concurrent and predictive validity in relation to current or ultimate driving performance than an appropriate road test Similarly, patients do not enter a hospital tagged with alternatives of probable diagnosis, indicated diagnositic procedures, and rational therapeutic measures from which the physician makes the most appropriate choice He is not only obliged *spontaneously* to generate relevant diagnostic hypotheses, order *relevant tests, eliminate all other diagnostic possibilities* than the one he designates as most probable, and prescribe appropriate treatment but in most instances he must also elicit the pertinent facts of clinical history, obtain significant data from observation and physical examination, and interpret the results of diagnostic tests It is apparent, therefore, that multiple choice tests, valuable as they are, cannot possibly serve as complete substitutes for open ended and practical examinations in the measurement of clinical competence in medicine

### *Reliability*

Any measuring instrument if it is to be used with confidence must exhibit a satisfactory degree of accuracy or reliability That is, it must yield self consistent scores If a clinical thermometer on three successive determinations, for example, yielded readings of 97°, 103°, and 99 6° for the same patient, it would not be considered very reliable Reliability of course, is a necessary but not a sufficient condition for using a test A highly reliable test may be totally invalid or may not measure anything that is psychologically or educationally significant The reliability of a single test score is expressed quantitatively in terms of the instrument s standard error of measurement If the standard error of measurement, for example, is 2 5, we can say that there are approximately two chances in three (more precisely 68 in 100) that the true score falls between 72 5 and 77 5 when the obtained score is 75 By definition, an unreliable test cannot possible be valid The necessary degree of reliability, however, depends on the use that is made of test scores If they are used for purposes of individual assessment and guidance, a much higher degree of reliability is obviously necessary than if they are used for gross screening or research purposes

Three types of coefficients are used to express the reliability of most psychological and educational tests The coefficient of *equivalence* is the correlation coefficient that results when scores derived from comparable sets of items are correlated This can be determined from equivalent (parallel) forms of the same test, or if only one form exists by correlating scores derived from one randomly drawn half of the test (for example, odd items), with scores derived from the other half of the test (even items) The latter coefficient of reliability is known as split half reliability , it also reflects, of course, internal consistency or generality over items, and is therefore, often referred to as a coefficient of internal consistency It represents a measure of reliability in terms of the equivalence between two halves of a homogeneous test, thus, it is primarily used when a parallel form of the test is not available for determining degree of equivalence between two different sets of items purportedly measuring the same ability or behavior Since the split half coefficient of reliability is obtained by correlating only half of the total number of available items in the instrument against the other half, it furnishes an underestimate of the instrument s actual coefficient of equivalence Thus to estimate the reliability of the full length instrument, a correction formula (Spearman Brown) is frequently applied Various mathematical formulas (for instance, Kuder Richardson Formulas 20 and 21) have also been devised for arriving at a more generalized estimate of generality over, or intercorrelation among homogeneous test items

The coefficient of *stability*, on the other hand, measures consistency over time or short term constancy of a trait when the same set of items is used It is determined from successive administrations of the same test Over short intervals of time the ability or trait being measured can be regarded as not undergoing significant change Over longer intervals, however, a loss of stability is more reflective of developmental changes in the nature of a trait or of inconstancy in rate of growth than of test unreliability

The coefficient of *generality* finally reflects the self consistency of a test when it is composed of heterogeneous but related measures of the same trait Tests of intelligence and of creativity for example typically consist of a battery of sub tests each of which measures a different facet of the trait in question When the scores on these sub tests are intercorrelated the average intercorrelation may be taken as the coefficient of generality Unless this coefficient is reasonably high it is obviously unwarranted to regard the various sub-tests as measuring anything in common

The length of a test is the most important single factor influencing its reliability Obviously the shorter a test is the more likely it is that test scores will be influenced by chance sampling or situational factors Failure to allow sufficient time for most students to complete a test has the same effect on reliability as reducing the number of items The reliability of a test is also decreased by inaccurate or subjective scoring and by the presence of items that lack discriminating power (see below) Lastly inadequate or fluctuating motivation may impair test reliability The inference that a test score actually measures true capacity rather than mere performance on a single occasion presupposes that the subject is trying his best As pointed out previously aptitude and achievement test scores are less reliable (and hence less valid) in the case of culturally disadvantaged pupils because of their unresponsiveness to speed pressure and their generally low level of test motivation

The effect of severe anxiety on aptitude and achievement test performance is somewhat indeterminable In general it tends to depress performance although much depends on the novelty of test items familiarity with testing and the adequacy of coping mechanisms Since high levels of anxiety can thoroughly disrupt the higher mental processes and even block any kind of response whatsoever it is not only important to allay test anxiety as much as possible but also to regard with caution the reliability and validity of test scores that are unduly influenced by anxiety[2] Both of these latter requirements can be taken into account by giving frequent tests instead of basing grades completely on final examinations When students are tested frequently they tend to be less anxious because of greater famili

[2] J T Hastings measured test anxiety by a questionnaire method as early as 1914 Since then standardized measures of test anxiety have been developed (Sarason and others, 1960) Although high tensions do not necessarily accompany low examination scores nor contrariwise pupils showing higher tensions as measured by the questionnaire at the time of an examination produce results which tend to deviate further from prediction than do the examination results of those who give evidence of lower tensions (Hastings 1944 p 161) W J McKeachie D Pollie and J Speisman (1955 p 94) showed that giving students an opportunity to write comments [about multiple choice questions] aids not only in reducing the threat but also in channeling the release of anxiety

arity with the test situation emotional desensitization to it, and the realization that their entire fate does not depend on a single score At the same time, the availability of many scores discounts the significance of any single score that is invalidated by extreme anxiety

### *Representativeness*

Almost all psychological and educational measures are based on the principle of sampling Since it is virtually impossible for example, to test a student for mastery of *all* of the facts, concepts, and principles in a given course of study, we typically select a sample of such content as a basis for assessing the universe from which the sample is drawn For this procedure to be logically defensible, at least two important conditions must be met (a) the sample must be adequately representative of the universe, and (b) within the constraints imposed by the requirements of representativeness and significance the sample must be randomly drawn The reasons for these conditions are rather self-evident if, for example, all of the examination items test knowledge of only one chapter of an assigned textbook or if the items on each chapter cover only a restricted segment of its content, the resulting achievement test score can hardly be claimed to measure knowledge of the textbook in question Not only would such an achievement test lack content validity, but *it* also would inevitably (and on a purely chance basis) overestimate the knowledge of some students and underestimate the knowledge of others Nevertheless many achievement tests particularly those that are teacher made, do not meet these two conditions representativeness and randomness

Two other unfortunate practices also commonly result from failure to appreciate the nature of a test as a representative sample Teachers who give hints about examination questions or who repeat the same questions year after year obviously render untenable the inference that scores on such an examination are actually representative of the students knowledge An even more serious error is committed by individuals who regard test scores based on a representative sample of items that are inferentially related to a given trait or ability, as more valid measures of the trait or ability in question than is direct behavioral evidence over a period of years This situation arises when test scores degrees or licenses are regarded as status symbols rather than as fallible sampling and inferential measures of competence The IQ and the M D are two such measures that have achieved almost magical or sacred status in our culture

*Total* evaluation is feasible for certain aspects of competence or achievement and can be used concurrently with a sampling approach A teacher, for example, may wish to evaluate *all* of his students homework assignments, laboratory reports, histology drawings workshop products, or clinical per formances All other factors being equal such measurement not only exhibits a high degree of validity and reliability but also tends to motivate students consistently to put forth their best efforts and to generate a high degree of responsibility and accountability for performance

### *Discriminating Power*

An obvious attribute of an effective test is ability to distinguish maximally between individuals who vary with respect to the trait or competence being measured In large part of course this attribute depends on the discriminating power of the component items and accounts for as well as reflects the reliability and validity of the instrument To some extent, however it depends on the *distribution* of the total scores and on whether the test provides adequate *ceiling* for superior persons in the group A *normal* distribution of scores for example provides maximum discrimination at both ends of the scale (where there are few scores spread out thinly) and less discrimination at the middle part of the scale (where many scores are bunched together) whereas a *rectangular* distribution of scores (an equal number of scores at all points on the scale) provides equal discrimination over the entire range A *skewed* distribution (where as disproportionate number of scores pile up at one end of the scale) on the other hand is most discriminating at the end where there are few scores and least discriminating at the opposite end

An effective test must also have sufficient ceiling to permit the superior individuals in a group to stand out as such Obviously if an achievement test is easy enough for the average person in the group to achieve a score of 90 percent it is accordingly impossible to distinguish between more and less knowledgeable students Maximum discriminability generally prevails when the average score is approximately 50 percent Adequate ceiling however should be provided by including a wide range of items carefully graded in difficulty rather than depend on a criterion of speed since the ability to answer questions quickly also reflects factors basically unrelated to superior competence or aptitude Difficulty level can be manipulated by varying such factors as abstractness complexity familiarity and degree of understanding required (mere comprehension versus application interpretation inference, analysis or synthesis)

### *Feasibility*

In addition to such theoretical considerations as validity reliability representativeness and discriminating power various practical matters must be taken into account before one can decide whether a proposed test is feasible First how significant is the information it yields that is how useful is it in interpreting the pupils' abilities, knowledge, and personality traits and in making educational and vocational decisions? Trivial test data are worthless irrespective of how reliable, valid or discriminating they may be. A feasible achievement test, for example, should provide differential feedback to both students and teachers about relative strengths and weaknesses in learning and teaching, as well as suggest reasons for same. Otherwise it is useless for diagnostic and remedial purposes. Second, a feasible test should be suitable in form and content for the age range of students for which it is intended. A third practical consideration is the cost of a test and the amount of time required to administer, score, and interpret it. Fourth, how objective is the scoring and how straightforward is the interpretation of the results? Is special training required to score and interpret the test? Does the test manual provide directions for administration and scoring, a table of norms, and guidance for interpreting scores?

## The Standardized Objective Test

Objective tests, although difficult and time consuming to construct, owe their great popularity in education to several factors. First and foremost, perhaps, is the fact that subjectivity and variability in scoring are eliminated. Precise and invariable criteria for scoring—typically a scoring key designating the correct answers—are available in advance. Second, the items are carefully and systematically selected so as to constitute a representative sample of the content to be covered and of the competencies to be evaluated. This implies precise advance specification of educational objectives—both in terms of the particular facts, concepts, principles and applications which the student is expected to master, and of the ways in which such mastery is supposed to be exhibited. Since the totality of desirable knowledge in a given area obviously cannot be tested, great care must be taken to secure a representative sample of significant (non-trivial) items that is both adequately comprehensive and places the desired relative weight on component topics. Herein lies the other great advantage of objective tests: the brevity of each item and the speed with which it can be answered permits a more comprehensive and systematic sampling of knowledge than is possible by any other means. Although the ability to recognize a correct alternative does not necessarily imply ability to recall it spontaneously, the correlation between the two abilities tends to be reasonably good (Plumlee, 1947; R. W. Tyler, 1934a).

An additional advantage in this connection is the possibility of refining the items, after initial use, for clarity and discriminability and of thus increasing test reliability and validity. Self-evidently, items that are answered correctly by all or most students are too easy to have any discriminating power for opposite reasons the same conclusion applies to items that are answered incorrectly by all or most students Further a good item is obviously one that is answered correctly more frequently by the more knowledgeable students (those making high total scores) than by the less knowledgeable students and answered incorrectly more often by the less knowledgeable than by the more knowledgeable students[3] Items that fail to meet these criteria are either deleted rewritten less ambiguously or replaced by other items

Analysis of the relative frequency with which wrong alternatives are chosen may also reveal either ambiguities in wording or the existence of a prevalent preconception or misconception If the latter is the case the item serves a useful diagnostic function and should not be altered In fact a multiple-choice item should be deliberately written so as to contain at least one wrong alternative that reflects a common bit of misinformation or a misconception The adequacy of learning and teaching can then be evaluated just as validly by the good students greater avoidance of such sucker alternatives as by their greater tendency to choose the correct alternative On the other hand if good students choose a particular wrong alternative more frequently than poor students there are grounds for believing that the item in question is misleading or ambiguous

Objective tests are also typically standardized with respect to the conditions of administration—the instructions the time limits the allowable help the permissibility of making calculations or of marking the alternatives and so forth thereby insuring comparability of scores Finally most standardized tests that are published provide the user with a table of norms based on a large and representative sample This makes possible the conversion of raw scores into percentile scores or grade equivalents

### *Criticisms*

In recent years objective tests have been subjected to vigorous criticism (Black 1963 M L Gross 1962 B Hoffman 1962) some warranted but much based on misunderstanding of their nature functions and inherent limitations First despite considerable improvement in this respect over the past decade many objective tests still measure rote recognition of relatively trivial and disconnected items of knowledge rather than genuine comprehension of broad concepts principles and relationships and ability to interpret facts and apply knowledge Paradoxically this shortcoming of objective tests has been magnified by the programmed instruction movement with its emphasis on small frame and step size

[3] In practice this item analysis function is performed by comparing the number of right and wrong responses on each item that are obtained by the upper and lower fifths or quarters of the distribution of total test scores

Second, because of unskillful construction of test items the correct answer is sometimes identifiable by means of unintentional hints, for example, the self evident implausibility of the wrong alternatives, the use of such words as "always Both of these deficiencies are easily correctable by using greater care in item construction by selecting more significant test items, by stressing items that require understanding thought, and insight, by including application and problem solving items and by placing greater reliance on delayed retention and transfer retention scores The multiple choice format minimizes the role of guessing It should be noted at this point, that unskillfully constructed essay and problem solving tests may also place a premium on the regurgitation of rotely memorized knowledge and on rote application of "type problem solutions

Third, the correct answer in multiple-choice tests may sometimes be either arbitrary or depend on abstruse hair splitting In some instances it may also favor the less knowledgeable or more shallow thinker and penalize the more sophisticated student who takes into account more subtle and penetrating considerations

Fourth the great emphasis placed on time pressure tends to favor the glib confident, impulsive, and test wise student, and to handicap the student who either is inclined to be cautious thoughtful and self-critical, or is unsophisticated about testing Ideally, a valid test of either scholastic aptitude or academic achievement places greater weight on power than on speed (Yates, 1961), discriminating ability is attained by providing a wide and carefully graded range of difficulty, with ample time for most students to complete the test, rather than by including twice as many items as the average student has time to answer In our opinion, the current emphasis on speed in most standardized tests of achievement detracts from their validity by placing a premium on factors that are intrinsically unrelated to genuine mastery of subject matter

Lastly, the limitations of stardardized testing must always be borne in mind For example, multiple choice tests by definition, cannot measure students' ability spontaneously to generate relevant hypotheses, to collect valid laboratory or clinical data, to marshal evidence in support of a proposition, to design an original experiment, to structure a cogent argument, or to do creative work Other kinds of measuring devices, however, are available to test the attainment of these latter objectives

## Interpretation of Achievement Test Scores

In general there are three different ways of interpreting achievement test scores The first method judges a student s performance against the standard of *his own* ability level as determined by his score on an aptitude test, a pretest, a prior achievement test, or an initial achievement test in the course This is important for both student and teacher since it indicates the extent to which normally expected progress is being made in the course The second method assesses the adequacy of a student's performance in relation to that of his peers, it is necessary both for grouping pacing, and the individualization of instruction as well as for making important decisions about his *educational and vocational future* As pointed out above, both kinds of assessment are essential and neither one precludes the other Each of these approaches is concerned with a *relative* standard of performance but in one case the individual serves as his own standard and in the other his performance is related to group norms

In some instances however, an *absolute* standard of performance is indicated which is quite independent of the performance of others or of the individual's relative standing in the group This is the case, for example, where mastery of a given topic subject or skill is a prerequisite for more advanced learnings and where a certain minimal level of competence is necessary before an individual can be entrusted with certain vocational roles such as lifesaver on a beach physician pharmacist secretary, railway engineer, or airplane pilot R Glaser (1963) designates such scores based upon an absolute standard of quality as *criterion referenced* measures in contrast to *norm referenced* measures based upon a relative standard Achievement test scores typically furnish both kinds of measures Raw scores or percentage scores are criterion referenced measures whereas percentile scores (scores indicative of the percentage of a designated population of scores exceeded by the percentile score in question) are norm referenced measures

In using the norms of standardized tests it is important to make sure that they are based on a sample that is both large enough to insure stability and adequately representative of the universe in which they purportedly pertain The particular norms used must also be relevant in the sense that they are based on groups of individuals who are comparable to the individuals we are testing For example in interpreting the achievement test scores of a particular twelfth-grade group in an American high school, we would want to use the norms of American twelfth graders generally, plus such other differential norms that apply to our group as sex, region, state, urban or rural area public or private high school For guidance purposes (grouping choice of courses college application), it would also be helpful to use the local school norms as well as the cut-off scores employed by various colleges in selecting candidates for admission

## Other Methods of Evaluation and Measurement

Because of limitations on the kinds of objectives that standardized short answer tests can measure, other methods of evaluation and measure ment are used concomitantly in most educational settings Thoughtful teachers do not place excessive reliance on standardized objective tests

### *Essay or Discussion Questions*

Essay examinations, despite their many disadvantages have a significant place in the evaluation program of a school They are particularly useful (a) where spontaneous recall of information and spontaneous generation of hypotheses are important aspects of the competencies being measured (for instance, formulation of diagnostic hypotheses differential diagnosis), and (b) in less well-established areas of knowledge where there is no single right answer' In addition, they test a student s ability to organize ideas and marshall evidence, to construct a cogent argument, to evaluate ideas critically, and to express himself clearly and convincingly Essay type questions also provide greater scope for original and independent thinking, and give some insight into the cognitive styles problem sensitivities, and problem solving strategies of students On the whole they are better suited than short answer questions for measuring students grasp of the structure of a discipline

On the other hand they are much less satisfactory than short answer tests for measuring knowledge of more established concepts principles, and information in a given subject matter field particularly where there is no premium on ability to recall and transform ideas spontaneously Since only a few questions can be asked on any examination, sampling of content is neither comprehensive nor representative, and scoring tends to be laborious and subjective, hence both reliability and validity are often unsatisfactory Further, essay examinations encourage bluffing, circumlocution, padding and discursiveness on the part of students, and tend disproportionately to reward those students who write neatly, excel in the mechanics of English composition (spelling, punctuation, diction, and style) and echo the views and biases of their teachers Finally, the very ease of constructing essay examinations encourages a rather cavalier and slipshod attitude toward evaluation on the part of those who use them

Many of the aforementioned disadvantages can be mitigated, however, by following a few simple rules By indicating explicitly the scope and dimensions of the expected answer, much of the ambiguity and vagueness of the global discussion question can be eliminated As a matter of fact, short essay type questions that are relatively limited and specific in scope may exhibit considerable reliability and validity, but by the same token they may also fail to test some of the distinctive competencies that the essay examination is designed to measure This format however, is particularly appropriate for problem solving exercises in such applied fields as medicine, where problems of differential diagnosis, the search for additional needed information, the interpretation of data, and proposed remedies can center on each of several short case presentations To minimize the strong chance factor in the particular questions that are selected in an essay examination students may be given some degree of choice in questions

It is also possible to reduce the subjectivity of scoring by using several readers and by establishing such separate explicit criteria for grading as content organization logic cogency clarity and fluency of expression Halo effect can be minimized by coding students papers and by scoring in turn each question for all students instead of completely grading each student s paper before turning to the next paper

Oral examinations typically enjoy the same advantages and disadvantages of the essay examination but in addition enable the examiner to probe more deeply when unsure of the student s knowledge or meaning and to cut short irrelevant and discursive answers In this sense they discourage bluffing On the other hand they appear to evoke much more disruptive anxiety than do written examinations and to favor the glib and socially poised individual

### *Work Samples*

In most areas of education but particularly in vocational professional artistic and physical training it is possible to assess the extent to which the objectives of education are actually being attained by directly appraising a performance or work product that is self-evidently reflective of the competence being taught Such work samples include laboratory skills clinical performance drawings themes research reports gymnastic or musical performance the use of tools art or shop products typing and stenographic performance and so forth They constitute much more direct and valid criteria of the competences involved than do short answer or discussion examinations which can only inferentially measure the same competences It is obviously much more important to know for example how well a student physician can interview examine diagnose and prescribe for an actual patient than how well he can answer questions about the theory and practice of medicine Such examinations also make possible direct assessments of such traits as flexibility resourcefulness perseverance and creativity Hence their value largely depends on the extent to which they are able realistically to simulate real life conditions of performance

The most serious disadvantages of these examinations are that they are time consuming expensive and difficult to construct in many areas It is also difficult to assure breadth and equivalence of sampling If hospital cases for example are used as test material for students in clinical medicine how adequately can a single case measure a student s ability and how does one equate cases for difficulty? This argues for the desirability of appraising *all* of a student s work products in a given course of study—all of his laboratory drawings or clinical performances or of using standardized (for instance, televised) case presentations that are uniform for all students.

Scoring presents still another difficulty and is no more reliable and valid than the observational and rating techniques on which it is based. These techniques can be materially improved if the dimensions on or criteria by which the performance is to be judged are specified in advance, if discriminably different points on a rating scale can be both described and quantified, if the ratings of several trained judges are averaged, and if ratings are made concurrently rather than retrospectively. Proper training of the judges includes discussion of the nature of the trait or competence to be rated, making a trial run of ratings, comparing ratings, and deciding how ratings are to be distributed over the scale. Final ratings, of course, are made independently. Halo effect can be minimized by having the rater judge each item on the scale for the entire group before proceeding to the next item.

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